The Great Basin Naturalist

VOLUME XXVII, 1967

EDITOR: VASCO M. TANNER
ASSOCIATE EDITOR: STEPHEN L. WOOD

PUBLISHED AT PROVO, UTAH, BY
BRIGHAM YOUNG UNIVERSITY

I

TABLE OF CONTENTS

Volume XXVII

Number 1 - April 22, 1967

On Two Little-Known Species of the Earthworm Genus *Diplocardia*. G. E. Gates 1
Spiders of the Nevada Test Site. Illustrated. Dorald M. Allred and D Elden Beck 11
Problems of Sampling Desert Arthropods Before and After a Thermonuclear Cratering Test. Illustrated. Clayton S. Gist 26
New Species of Bark Beetles (Coleoptera: Scolytidae), Mostly Mexican. Part VII. Illustrated. Stephen L. Wood 36

Number 2 - September 5, 1967

A Comparative Study of the Mountain Brush Vegetation in Utah. Illustrated. Elray S. Nixon 59
Predaceous-Scavenger Ants in Utah. D Elden Beck, Dorald M. Allred, and William J. Despain 67
New Records and Species of Neotropical Bark Beetles (Scolytidae: Coleoptera). Stephen L. Wood 79
A New Species of *Spinibdella* from Utah (Bdellidae: Acarina). Illustrated. Clive D. Jorgensen 98
Notes on *Eriogonum* - III on the Status of *Eriogonum pauciflorum* Pursh. Illustrated. James L. Reveal 102

Number 3 - November 30, 1967

New Records and Species of Neotropical Bark Beetles (Scolytidae: Coleoptera) Part II. Stephen L. Wood 119
On the Earthworm Fauna of the Great American Desert and Adjacent Areas. G. E. Gates 142
A New Name for a Utah *Lepidium*. Illustrated. James L. Reveal 177

Number 4 - December 30, 1967

Notes on *Eriogonum* - V. A Revision of the *Eriogonum Corymbosum* Complex. Illustrated. James L. Reveal 183
D Elden Beck (1906-1967). Illustrated. Vasco M. Tanner 230
Index 241

Volume XXVII, No. 1
April 22, 1967

The Great Basin NATURALIST

Published by
Brigham Young University

The Great Basin Naturalist
Published at Provo, Utah by
Brigham Young University

Volume XXVII April 22, 1967 No. 1

ON TWO LITTLE-KNOWN SPECIES OF THE EARTHWORM GENUS *DIPLOCARDIA*[1]

G. E. Gates[2]

Few zoologists realize how little is known about the earthworms of North America. An erroneous assumption that their distributions in the United States are adequately characterized certainly seems to have been involved in some recent zoogeographical discussions.

During the last 16 or so years, Professor D Elden Beck of the Department of Zoology and Entomology, Brigham Young University, Provo, Utah, has been collecting earthworms on his travels through various states from Maine to California. Those collections eventually will provide information about some of the many areas with unknown faunas. A series from a single site provides the basis for much of this first report on the "Beck" material.

That series is of interest for two reasons: (1) It provides the first record of an earthworm from the state of New Mexico. (2) The species is native, not exotic as is each of the three hitherto reported from the adjacent state of Arizona.

A single specimen of the same species from Wisconsin, under different circumstances, could have been of equal interest. However, it is noteworthy that only two megadrile taxa had been reported from Wisconsin hitherto. *Alltolobophora turgida Eisen*, 1874, recorded by Ude in 1885, could have been any one or more of three different species. Another, *Sparganophilus eiseni* Smith, 1885, was recorded by Hague from the state as long ago as 1923.

No single species was added to the short list of Arizona earthworms since 1900. Fortunately, Professor Beck has interested Professor T. W. Barrett of Arizona State University, Tempe, in adding to our limited knowledge of the area. As a result of Professor Barrett's early collecting, it is now possible, for the first time, to record a North American native from Arizona.

Diplocardia verrucosa Ude

1895. *Diplocardia verrucosa* Ude, Zoologischer Anzeiger, 18:339. (Type locality, Omaha, Nebraska. Types in the Zool. Mus., Hamburg, Germany.)

1. From research financed by the National Science Foundation.
2. University of Maine, Orono.

1962. *Diplocardia verrucosa* Murchie, Ohio Journal of Science, 62:185. (Two subspecies recognized after examination of a "syntype" and other specimens.)

Habitat.—New Mexico (Hidalgo County). Rodeo, six inches below the surface in sticky, black, gumbo-like soil under a rank growth of Russian thistle, February 27, 1966, 1 (+ 16 mostly juvenile and 10 fragments?)-0-30. D E. Beck.

Wisconsin (Dane County). Between Arena and Mazomanie, damp, willow, swamp loam, September 22, 1963, 0-0-1. Christina Hobby.

External Characteristics.—Size, 80 by 4 mm. (Wisconsin), to 107 by 3 mm. (New Mexico, but softened). Undisturbed specimens in the soil, according to Professor Beck, reached a length of six inches. Segments, 118 (Wisconsin). Color, white, clitellum yellowish brown. Prostomium, epilobous; tongue narrowing to a point, or open, with a transverse furrow slightly behind anterior margin of the peristomium. Secondary annulation, one presetal and one postsetal secondary furrow present per segment beginning with v or vi. Setae, small, retracted; follicles not visible in coelomic cavities, *AB* ca. = *CD*, little difference in sizes of *BC* and *AA* or *BC* <*AA* (Wisconsin), *DD* ca. = ½ C. *a,b*/xix, xxi penial, *a,b*/xviii lacking. Nephropores, inconspicuous whenever distinguishable at or slightly above *D* and so in a single rank on each side of the body. First dorsal pore, at 9/10 (1 specimen), 10/11 (9, including Wisconsin), ?11/12 (2), 11/12 (3).

Spermathecal pores, transverse slits (New Mexico), small, but obviously larger than the other genital apertures, superficial, at or close to *A*, just behind intersegmental furrows 7/8 and 8/9. Centered around each spermathecal pore (New Mexico) is a small circular area of slight tumescence. Female pores, paired, anteromedian to *a*, in some New Mexico specimens within a single small field lacking clitellar coloration. Seminal grooves, broad and shallow, nearly straight, in *AB* between eq/xix and eq/xxi. Male pores, each on a tiny spheroidal protuberance from bottom of seminal groove, at or immedately behind probable level of 19/20. Two follicle apertures are present at each end of a seminal groove, sometimes definitely not within the grooves. The body wall seems to be slightly thickened ventrally in xix-xxi, but aside from the grooves there is no specially characterized male field (New Mexico). The ventral region between grooves of the Wisconsin worm is slightly tumescent and after staining seemed to contain three pairs of slight circular tumescences. Clitellum, saddle-shaped (all), extending down to *B* (Wisconsin), nearly to mV (all New Mexico), reaching into xiii and xix (Wisconsin), in xii-xix (1), xiii-xix (28), xiii-xx (1), lacking ventrally in xix or xix-xx.

Genital markings, lacking (all New Mexico specimens). Each marking of the Wisconsin worm has a circular area of translucence surrounded by a broad rim of slight epidermal tumescence so

shaped that the marking has a circular to shortly and transversely elliptical shape. Markings, usually paired but not median when single, usually in the region of *AB* or centered there. Locations, only approximate because of invisibility of intersegmental furrows in some areas, 8/9, postsetal in ix, x, (in x on left side only and centered at *A*), 10/11 just lateral to *B*, presetal in xviii, xix, postsetal in xxi, xxii, xxiii, perhaps also in xxiv but there tumescence slight and no translucence is recognizable.

Internal Anatomy.—Septa, 4/5 membranous, 5/6 muscular and translucent, 6/7-8/9 (Wisconsin) thickly muscular, thickness of 9/10-12/13 decreasing posteriorly, 6/7-12/13 (New Mexico) slightly muscularized. The usual subpharyngeal and subesophageal horizontal mesenteries are present. Pigment, none visible in sections through the body wall. A special mid-dorsal, longitudinal muscle band is present from the region of 10/11 to the hind end. Pharyngeal glands, confined to region in front of 4/5.

Gizzards, rather weak, in v-vi (11). Calciferous glands and lamellae, lacking. Esophagus (Wisconsin) not especially wide in any segment, with a ventral typhlosole and numerous, low, closely crowded nonlamelliform vertical ridges in x-xiii. Intestinal origin, doubtfully in xvi (Wisconsin and 2, New Mexico), in xviii (8, New Mexico). Such variation seemed unusual. After determining intestinal origin in the eight specimens, the other two New Mexico worms were reexamined. An esophageal valve was unrecognizable. The gut in xvi-xvii certainly was grossly distended by the ingesta. Condition does not permit determination of the nature of the tissues in the region in question. Typhlosole, beginning in the region of xx-xxi, relatively fairly high, simply lamelliform, ending abruptly in the 87th segment (Wisconsin).

Dorsal blood vessel, single from the periproct to region of iii where it passes under the brain and bifurcates (Wisconsin). The branches shortly attenuate to invisibility. Ventral trunk, complete. Supra-esophageal trunk, at least in part empty and extent not determinable. Extra-esophageal trunks, median to hearts, close to or on the gut in vii-xiii. Posterior lateroparietal trunks, no trace recognized though probably present. Subneural trunk, unrecognizable throughout and probably lacking. Hearts, of vii-ix (perhaps also of x) lateral, of xi-xii probably latero-esophageal. Last pair of hearts, in xii (11). A large, looped vessel from the dorsal trunk passes down to the ventral parietes on each side of the body and just in front of each septum in the intestinal region. A short, transparent thread sometimes seems to connect such a segmental vessel to the ventral trunk.

Nephridia, present from ii, without recognizable vesicles, small, simple, investing peritoneal cells not distended, funnels about at *A*, ducts passing into parietes at *D* gap in the musculature.

Seminal vesicles, medium-sized, acinous, in ix and xii; the anterior pair sometimes with several fairly large lobes, the posterior

pair sometimes with more but smaller lobes. Sperm ducts, without epididymis, coming into contact in xiii, at least through xviii not united, in xix just lateral to prostatic ducts, not traceable to the male pores. Prostates, large, in some or all of xiii-xxiv, once reaching into xxviii, to 15 mm. long and 0.5 mm. thick. Prostatic ducts, only a little thicker than the slender penisetal follicles, without muscular sheen, 2+ mm. long (Wisconsin), 1+ mm. long (New Mexico). Diagonal muscles in region of the male field (New Mexico) are few and weak. Penisetal follicles, shorter than the prostatic ducts, do protrude slightly into coelomic cavities.

Spermathecae, small to medium sized, ampullae empty and strongly contracted (Wisconsin), large and reaching to the dorsal parietes (New Mexico). Ducts, slender and shorter than the ampullae. Diverticulum, approximately discoidal, vertically placed, with a row of seminal chambers somewhat like the teeth of a comb, opening into the duct just below the ampulla. As so described, the diverticulum looks much the same as in various other species of *Diplocardia*. However, in present specimens of *verrucosa*, as well as in various congeners, individual organs often deviate more or less widely from the norm described above. Thus, the seminal chambers may not be in a row but arranged in an arborescent pattern. The organ may be more or less deeply bi-, tri-, or quadrilobed or otherwise. One lobe may be much larger than the others and without iridescence. The bottom of each of several New Mexico ampullae was occupied by a flat and markedly iridescent disc. That material is continuous with the contents of diverticular seminal chambers. Obviously the seminal chambers did not have space enough to hold all of the seminal fluid.

Follicles of *a* and *b* setae of viii-x are just visible in the parietes and probably do not contain specially enlarged and modified (copulatory) setae.

Ovaries, fan-shaped, each with several egg-strings, which are short (New Mexico) or long (Wisconsin). Ovisacs, small, in xiv (Wisconsin).

Reproduction.—Iridescence on male funnels is brilliant and indicative of massive production and aggregation of sperm. Iridescence also is obvious in spermathecal diverticula, proving that copulation had been completed. Accordingly, and in absence of any definite evidence to the contrary, reproduction can be assumed to be amphimictic.

Ingesta.—Very fine-grained, black (Wisconsin) or red (New Mexico) earth in which few plant fragments were recognizable. The species appears to be geophagous.

Parasites.—Coelomic cavities of posteriormost segments (Wisconsin) were filled with spheroidal cysts. Nematodes and other foreign organisms were not seen.

SYSTEMATICS.—The two subspecies are distinguished from each other by situation of ventral boundary of the clitellum, location of spermathecal pores, shape of seminal grooves, and patterns of genital-marking location. The Wisconsin worm has genital markings as do both subspecies, is more like the Oklahoma subspecies, *recta*, as regards clitellar boundaries and spermathecal pore locations. New Mexico worms also have the *recta* location of spermathecal pores but a *verrucosa* clitellar boundary and are distinguished from both subspecies by absence of genital markings as well as by a more posterior intestinal origin.

REMARKS.—One fourth of the area of Wisconsin is a major part of some 15,000 square miles that until recently was called the Driftless Area. The name indicated a belief that the region had not been glaciated during the Quaternary. A much better chance of survival would seem to have been provided earthworms by such an area than by the possibly bare, mountain-peak nunataks on which living organisms sometimes are thought to have survived through Ice Age millennia. Collections eventually procured for the author from the Driftless Area contained only one specimen of a native American species. Any importance that individual might have had was dissipated by geologists who found that all of Wisconsin had been covered by ice. Although the glaciation of the region in question is described as light, earthworms are unlikely to have survived therein.

D. verrucosa is, of course, endemic somewhere in America—though just where still is to be determined. No information is available as to self-migration rate of any diplocardia. There is, however, no good reason for believing sufficient time has been available for migration to Wisconsin from well below the southern limit of the ice sheet. Presence in Wisconsin then is due to transportation and probably by man since the first European settlement. Elsewhere *D. verrucosa* has been recorded from Lake St. Marys, Ohio (a single specimen), central Illinois (where Harman, 1960, found it in 16 counties), Omaha (Nebraska), and two counties in Oklahoma. The Ohio site, as also all Illinois sites, is within the glaciated area. Introduction to Ohio and to Nebraska is anticipated. Unfortunately, our knowledge of Illinois earthworms dates only from 1885, but even so, introduction to central Illinois does not seem impossible or even improbable. Certainly there seems to be no reason at present for suspecting introduction by man to the two Oklahoma counties.

The other distributional discontinuity may at first seem suggestive of human introduction to New Mexico. However, the paucity of information about the earthworms of an area extending from central Texas to the Pacific Ocean at present contraindicates any such conclusion. Also, very much more needs to be learned about distributions within the diplocardian refugium, Texas straight east to the Atlantic Ocean.

Diplocardia texensis Smith

1924. *Diplocardia keyesi texensis* Smith, Proceedings, United States National Museum, 66(12):2. (Type locality, Chillicothe, Texas. Types, 2, both sectioned, in the U. S. Natl. Mus.)

1965. *Diplocardia* sp., Bhatti, Proceedings, Pennsylvania Academy of Science, 39:8.

Habitat.—Arizona (Gila County). Watershed F at 3 Bar Watershed, at *ca.* 3,800 feet, upper six inches of soil underneath a *Turbinella* oak bush, March 31, 1966, 5-0-0-2. T. W. Barrett per D E. Beck. Sierra Ancha Exp. Forest, moist, dark, clay loam (soil sample #107) from thicket of walnut and oak trees, about one mile from waterfall at head of Workman Creek, at 7,450 feet, November 22, 1966, 0-1-0. Floyd Stockton per T. W. Barrett.

Pennsylvania (Delaware County). Swarthmore, bank of Crum Creek, November, 1962, 0-1-1, H. K. Bhatti.

Texas (Lubbock County). Lubbock, flower bed, August 16, 1955, 0-0-2. J. E. Sublette per W. J. Harman.

(Victoria County), 0-1-0, (U.S. Natl. Mus. No. 57489). Victoria, 5 miles southeast of town, prairie region, October 7, 1941, 0-2-13. J. D. Mitchell. (U.S. Natl. Mus. No. 57463).

External Characteristics.—Size, 44-100 by 2.0-2.5 mm. Segments, 74, 83, 100 (posterior amputees?), 121 (Swarthmore), 122 (+?), 129, 130, 131 (2 specimens), 132, 134, 135, 136, 142, 147, 156 (Lubbock). Color, white. Secondary annulation, usually pronounced behind male field except in last 8-20 segments, a pre- and postsetal secondary furrow per segment, the posterior secondary annulus usually with a well-marked tertiary furrow and other tertiary furrows may be present. Such annulation makes counting of segments very difficult especially as setae often are unrecognizable externally and dorsal pores are not distinguishable. Body, with a nearly circular cross section posteriorly. Prostomium, epilobous, tongue closed (Swarthmore and 5 Arizona), open (17). Setae, present from ii where none are lacking, AB = or slightly < CD, BC much < AA, DD ca. = ½ C, posteriorly BC may become so much smaller as to be only slightly larger than AB, a, b follicles of viii, ix, xviii-xx confined to parietes and in them setae usually seem to be lacking. Nephropores, when detectable, about at D in iii-vi or vii (several), posteriorly at or well above D but without regular alternation in level, and accordingly in a rather irregular single rank on each side of the body. First dorsal pore, at 7/8? (1 specimen). ?8/9 (4), 8/9 (1), ??9/10 (1), ?9/10 (1), 9/10 (3), ??10/11 (2), ?10/11 (1), 10/11 (2), ???11/12 (1), ??11/12 (1).

Spermathecal pores, sometimes obviously larger than other genital apertures, superficial, each within a very small protuberance, at or close to A and slightly or immediately behind 7/8, 8/9. Female pores, anteromedian and much closer to a than to each other, within a distinctly delimited transverse area (occasionally dumbbell shaped) that covers the anterior half of xiv in AA (14),

a female field unrecognizable in the other worms. Prostatic pores, at ends of seminal grooves and hence at eq/xx and eq/xxii, in *AB*. Male pores, each on a very small tubercle in a seminal groove and at or just behind level of 20/21, perhaps about at eq/xxi of one Texas worm. Seminal grooves, nearly straight, deep and wide. A postequatorial and preequatorial furrow in xxii, between the *A* meridians, of the Swarthmore specimen, at first appear to be median continuations of 20/21 and 21/22, with the seminal grooves seemingly confined to xxi. Intersegmental furrows are, however, obliterated across the male field. The latter is not distinctly demarcated, nor is it depressed, but it is distinguished by a greater epidermal opacity that extends well into *BC* between 19/20 and 22/23. Genital markings, lacking (all).

Clitellum, reddish brown reaching just below *A* (Swarthmore), to just below *C* in xxi, to *mBC* in xx, in other segments to well below *A* or nearly to *mV*, from eq/xiv to 16/17 (1),) or annular in xiv (1), xiv-xv (1), dorsal pores occluded, setae retained, intersegmental furrows obliterated (Swarthmore) or faintly indicated dorsally and gradually becoming more obvious ventrally (some Texas), in xii-xx (Swarthmore, 1 Arizona), xiv-xix (12), xiii/n-xix (1), xiii-xx (2), xii-xxi (Lubbock).

Internal Anatomy.—Septa, 4/5 membranous, 5/6 slightly thickened, 6/7-10/11 increasing a little thicker, 11/12 muscular and opaque or translucent, 12/13 slightly muscular and translucent. Insertions on parietes laterally of 6/7-10/11 are posterior to levels of corresponding intersegmental furrows. Special longitudinal muscle band at mD, too indistinct to be helpful in determination of function of pore-like markings. Gaps in longitudinal musculature show that *AB* obviously < *CD*. Pigment, unrecognizable in sections of body wall.

Gizzards, two, in v-vi (14). Calciferous glands and lamellae lacking. Esophagus usually of nearly uniform width throughout, very slightly widened in xii-xiii, xii-xiv, viii, or xiv and then thin-walled, or even much widened in xviii (2). The inner wall may have at mV a well-marked and blood-gorged ridge lateral to which there are low and rounded, red or white, nonlamelliform, vertical or longitudinal ridges, or ridges may be replaced by villiform protuberances. Intestinal origin, in xix (12). A widening of the gut in xviii of two worms is believed not to be intestinal but condition did not permit certainty. Typhlosole, first recognizable in region of xxi-xxiii, low but thickened lamelliform, height gradually decreasing posteriorly, unrecognizable behind 50th (1), 80th (1), 63rd (147), or 74th (of 142), segments. The lamella in a posterior amputee of 83 segments was rudimentary behind the 44th and was unrecognizable behind the 63rd.

Dorsal trunk, single throughout (5), complete, bifurcating under brain, the branches uniting (1) to become the ventral trunk which also is complete. Supra-esophageal, single, adherent to gut reaching

into ix and xii. Extra-esophageals, median to hearts, on gut from ix or x through most of xiii. Posterior lateroparietal trunks recognized only from xxi or xx, turning up to join the extra-esophageals on the anterior face of 12/13. Subneural trunk, no trace recognized in any dissected specimen, probably lacking. Hearts, in v not traceable all the way to ventral trunk, in vi-ix lateral, in x-xii probably latero-esophageal though no blood is present in filaments passing to dorsal trunk, last pair in xii (14). Segmental commissures, behind clitellum are covered by a layer of chloragogue that often is thicker than the vessel itself.

Nephridia, small, simple, seemingly avesiculate, on parietes in *AD* or from *mBC* to somewhat lateral to *D*, ducts passing into parietes about at *D* (or? entrance often not recognizable because of condition).

Seminal vesicles, acinous, nearly filling coelomic cavities (Swarthmore) but larger in xii. Vesicles of ix were not found in several Texas specimens and must have been rather small unless disintegration was involved. Sperm ducts, slender, those of a side uniting in xx shortly before disappearing into the parietes of xxi. Prostates, 5-9 mm. long (Swarthmore and some Texas), *ca.* 2 mm. long and laterally directed in own segments (Lubbock), or in a U-shaped loop in own segment, or variously twisted or extended, in one worm reaching back into xxviii. Ducts, slender, without muscular sheen, 1-2 mm. long, sinuous or in one or two shortly U-shaped loops, passing into body wall at *B* gap. Diagonal muscles, although a number are present in xx-xxii, appear to be weak, no depression or elevation of male field was recognizable. Follicles of ventral setae may protrude slightly into coelomic cavities of xx and xxii but often seem to have no shafts. When present, setae are straight or nearly so, unornamented or with several fine teeth scattered near the tip.

Spermathecae, small, medium-sized, or reaching to or slightly above level of dorsal face of gut. Ducts, shorter than, as long as, or somewhat longer than the ampullae, narrowest within the parietes and gradually widening entally but without becoming markedly thickened. Diverticulum, as usual attached by a mesentery to the posterior face of the septum in front, along lateral face of duct entally, rather sausage-shaped, sessile (no stalk), opening into duct directly through a single aperture in a middle portion, with 2-5 seminal chambers indicated by the nearly discrete balls of sperm. Copulatory setae were not recognized in ventral follicles of viii-ix.

Ovaries, fan-shaped, with several short or long (and then with as many as 20 ova) egg strings. One egg string of a Texas specimen passes well down into the oviduct of its own side. Oviducts, narrowed behind 13/14. (Ovisacs, recorded by Smith, were not recognized.)

Reproduction.—Spermatozoal iridescence is brilliant on male funnels of dissected clitellate specimens with ovarian ova in discrete egg strings. Iridescence in spermathecae was confined to the diverti-

cult, and as usual in worms of many other species, was not recognizable in the main axis. Iridescence was lacking in Texas individuals with ovaries still not separated into discrete egg strings even though clitella seemed to be well developed. Copulatory transfer of sperm having been demonstrated by the spermathecal iridescence, reproducing yellowish or reddish fragments.

Distribution.—A self-acquired range from Pennsylvania to Arizona would be very much larger than that of any other diplocardia. Such is not to be expected of a species that seems, in several ways, to be highly specialized. Absence of records for *texensis* between the Delaware and Mississippi Rivers is of no significance at present because of the paucity of information about earthworms of that area.

Several diplocardias probably have been carried around the United States by man who may have been responsible for presence of *texensis* in the vicinity of Philadelphia as well perhaps as also in Arizona.

Systematics.—Relationships suggested by the male terminalia are with *Diplocardia keyesi* Eisen, 1896, known only from descriptions of a single sectioned worm from Baja, California. Differences from worms herein referred to *texensis* now seem too great to be attributable to individual or even to intraspecific geographic variation. An intestinal origin in xv, in *Diplocardia*, certainly seems to be primitive. Origin in xix, recorded for each of thirteen specimens of *texensis*, now seems to represent greatest esophageal elongation in the genus. However, much more information about variation in each of the two taxa is needed.

Parasites.—Two small nematodes were found in coelomic cavities of a Texas worm.

Remarks.—Intestinal contents show the worms are geophagous. Soil particles were mostly quartz grains along with bits of mica and black mineral particles of similar size (Pennsylvania) or (Lubbock worms) rounded quartz grains with occasional black bits and numerous yellowish or reddish fragments.

Unusual thickness of the clitellum of one Texas worm is not associated with presence of mature sperm but with spermathecae and ovaries that seemingly are juvenile. The clitellar tumescence may then sometimes be a preservation artifact rather than an indicator of height of breeding activity.

Usually seminal grooves or diplocardias are recognizable before the epidermis of clitellar segments begins to become tumescent and also after that condition has completely disappeared. As types were said to be clitellate, supposed absence of seminal grooves needs an explanation, especially as there seems to be no reason to suspect that parthenogenesis (which would allow their elimination) is involved.

References

Hague, F. S. 1923. Studies on *Sparganophilus eiseni* Smith. Transactions American Microscopical Society, 42.

Harman, W. J. 1960. Studies on the taxonomy and musculature of the earthworms of central Illinois. Thesis, University of Illinois.

Murchie, W. R. 1962. A new subspecies of diplocardian earthworm from Oklahoma. Ohio Journal of Science, 62:185-190.

Ude, H. 1885. Ueber die Rückenporen der terricolen Oligochaeten, nebst Beitragen zur Histologie der Leibesschlauches und zur Systematik der Lumbriciden. Zeitschrift für wissenschaftliche Zoologie, 43:87-143.

SPIDERS OF THE NEVADA TEST SITE*

Dorald M. Allred and D Elden Beck[1]

Introduction

Since 1959, the Department of Zoology and Entomology of Brigham Young University, under contract with the U.S. Atomic Energy Commission, has conducted ecological studies at the Nevada Test Site. Primary objectives are to establish baseline data as a prerequisite for determining the effects of nuclear testing on native animals. Allred, Beck, and Jorgensen (1963) discussed the biotic communities of the test site, and summarized the initial collection data on some predominant species, including the spiders identified to that date.

No effort was made to specifically collect spiders in all of their habitats. However, those reported here were taken in connection with other studies, and reflect observations made on a daily basis for the collection methods applied. Principal methods of collecting were can pit-traps and berlese funnels (*ibid.*: 8-9; Allred and Beck, 1964), and a few were taken by hand. We feel the present listing is a good representation of the spiders which may be considered principally terrestrial in habit. Specialized collecting applied to all types of habitats would likely reveal many additional species. For example, the whole range of flower-inhabiting spiders was not investigated, nor the collection of specimens by net-sweeping of plants. A number of new species were taken, but these will be described in a subsequent paper by Dr. Willis J. Gertsch.

We are grateful to Dr. Willis J. Gertsch, American Museum of Natural History, New York, N.Y., for the identifications of the specimens and for checking the names used in this manuscript. Collection and identification of specimens, and analysis of data (in part) were accomplished under AEC research grants AT(11-1)-786, AT(11-1)-1326, AT(11-1)-1336, and AT(11-1)-1355.

In the following discussion a phylogenetic presentation has not been followed. Families and the species assigned to them are listed alphabetically for convenience. The total numbers of spiders collected are indicated, and the months in which they were taken are listed. Their relative abundance in each plant community is based on the number collected in relationship to the number of collecting attempts which varied between different communities (Table 1). Where sex is indicated, the specimens are adults. Sex determination was not made for the immature specimens in most cases.

Agelenidae

Agelenopsis aperta Gertsch. Three females were taken in July,

*B.Y.U.-A.E.C. Publication No. COO-1326-5.
1. Department of Zoology and Entomology, Brigham Young University, Provo, Utah.

October, and November, and four immatures from May through July. Two spiders were found adjacent to the pond at Cane Springs.

Calilena restricta Chamberlin and Ivie. Thirty-five males were taken from August through December and in February, mostly in October. Eighteen females were taken in April, August, and from October through February, mostly in November. Fifty-three immatures were taken from January through November except in February, and mostly during June, July, and August.

Circurina utahana Chamberlin. Four males were taken in November and December, two females in December and January, and one immature in August.

Argiopidae

Apollophanes texana Banks. One male was taken in May, and four females in June and July. One spider was taken adjacent to the pond at Cane Springs.

Metepeira gosga Chamberlin and Ivie. One male was taken in August, 15 females in June and August (mainly August), and 17 immatures in June, July and August. Five specimens were taken adjacent to the pond at Cane Springs.

Tetragnatha laboriosa Hentz. One immature was taken in March.

Caponiidae

Orthonops getrschi Chamberlin. Fifteen males were collected from April through December, except in August. Twenty-seven females were taken from March through September, mostly in May. Six immatures were collected in July, August, and October.

Tarsonops sp. One male was taken in September, and six females in July, August, and October.

Clubionidae

Anyphaena sp. One immature was taken in October.

Castianeira sp. One immature was collected in October.

Corinna bicalcarata Simon. Three males were taken in September and October, and three females in May, July, and August.

Micaria gosiuta Gertsch. Eleven males were taken in August and September (mostly in September), and one female in September.

Neoanagraphis chamberlini Gertsch. Seventy-six males were taken in August, September, and October (mostly in September); 12 females from February through October, except in May; and 66 immatures from April through October, mostly during June, July, and August. One spider was taken adjacent to the Cane Springs pond.

Neoanagraphis pearcei Gertsch. Forty-seven males were taken in September and October (mostly in October), one female in July, and nine immatures in June, August, September, and October.

Phrurotimpus sp. One male was taken in August.

Piabuna nanna Chamberlin and Ivie. One female was taken in September.

Syspira electica Chamberlin. A total of 113 males was taken from April through July and in October, mostly during May and June. Eighty-two females were collected from April through September, mostly in June and July. A total of 390 immatures was taken from April through October and in December, mostly during July and August. Two spiders were taken adjacent to the Cane Springs pond.

Dictynidae

Dictyna calcarata Banks. One male and seven females were taken in July, and seven immatures in July and August. One specimen was taken adjacent to the pond at Cane Springs.

Dictyna personata Gertsch and Mulaik. One male was collected in November, and two females in May and June.

Dictyna reticulata Gertsch and Ivie. Six males, 12 females, and seven immatures were taken in June and July, and one immature in October. Twenty-four of these were taken adjacent to the pond at Cane Springs.

Dictyna tucsona Chamberlin. Two immatures were taken in June and July.

Mallos mians Chamberlin. One male was collected in October.

Mallos pallidus Banks. Four males, three females, and eight immatures were taken in July, all adjacent to the pond at Cane Springs.

Diguetidae

Diguetia canities McCook. Three females were taken in May, July, and August, and one immature in June. One spider was taken adjacent to the pond at Cane Springs.

Diguetia signata Gertsch. One male was collected in June, and one female in May.

Filistatidae

Filistatt utahana Chamberlin and Ivie. Six males were taken in June and July, one female in September, and two immatures in June.

Gnaphosidae

Cesonia classica Chamberlin. Nineteen males were taken in June, July, and August (mostly July), 13 females from June through September, and 14 immatures in May, June, July, and October. One spider was taken adjacent to the Cane Springs pond.

Drassodes celes Chamberlin. One male was collected in April.

Drassyllus irritans Chamberlin. Thirty-one males were taken from February through June and in November (mostly in April), 47 females from April through August (mostly in June and July), and 47 immatures from February through December (except in April and June), mostly in August.

Drassyllus moronius Chamberlin. Four males were collected in May and November, four females in May, and four immatures in March, May, September, and October.

Gnaphosa californica Banks. One male was collected in November, nine females in June and November, and 11 immatures in July, August, and November.

Gnaphosa hirsutipes Banks. Twenty-four males were taken from March through July and in November, 17 females in February, May, and from July through November, and 34 immatures every month except April.

Hapuodrassus eunis Chamberlin. A total of 149 males was taken from October through May, mostly from February through April. Eighteen females were collected from January through June. A total of 204 immatures was collected, and every month was represented except May. Greatest numbers were found from October through January.

Herpyllus hesperolus Chamberlin. Sixteen males were taken during March, April, May, and December (mostly in April). Ten females were collected in April, June, and July. Forty-five immatures were taken representing every month except April. One specimen was taken adjacent to the Cane Springs pond.

Megamyrmecion naturalisticum Chamberlin. Nine males were collected from April through August, six females in June, July, August, and October, and six immatures from August through November.

Nodocion utus Chamberlin. A female was taken in July, and two immatures in July and September.

Zelotes monachus Chamberlin. Thirty-eight males were collected from April through October (except July), mostly during April, May, and June. Thirteen females were taken from March through July and in October. Twenty-six immatures were taken from March through October.

Zelotes nannodes Chamberlin. Two males and four females were collected in June.

Zelotes puritanus Chamberlin. One female was taken in May and an immature in July.

Heteropodidae

Olios fasciculatus Simon. One female was collected in September, and an immature in July.

Homalonychidae

Homalonychus theologus Chamberlin. Four males were collected in October, one female in April, and four immatures in April, June, and October.

Linyphiidae

Ceratinopsis sp. One male was collected in January.

Erigone dentosa Cambridge. Three males were collected in June and October, four females in January, March, and September, and three immatures in October. Nine of the specimens were taken adjacent to the Cane Springs pond.

Meioneta fillmorana Chamberlin. One male and one immature were taken in November.

Meioneta formica Emerton. Two females were taken in January and April.

Spirembolus sp. One female was taken in February.

Tapinocyba sp. One male was taken in November.

Lycosidae

Alopecosa kochi Keyserling. Two males were taken in March and April, and one female in May.

Geolycosa rafaelana Chamberlin. Three males were collected in June and July, and one immature in August.

Pardosa ramulosa McCook. Six males, two females, and five immatures were taken in March, all adjacent to the Cane Springs pond, and one male was collected in November.

Schizocosa sp. One immature was taken in June.

Tarentula kochi Keyserling. Eighty-seven males were taken from October through May, mostly from January through March. Forty-five females were taken every month except August, mostly from November through March. A total of 111 immatures was taken, representing all months except February.

Mimetidae

Mimetus eutypus Chamberlin and Ivie. One immature was taken in October adjacent to the Cane Springs pond.

Oxyopidae

Oxyopes tridens Brady. Fifty-two males were taken from May through August, 11 females from June through September, and 20 immatures from June through November. Greatest numbers of all stages were taken during July.

Pholcidae

Physocyclus tanneri Chamberlin. Three males were collected in August and November, and six females and five immatures in June,

July, and November. Seven spiders were taken adjacent to the Cane Springs pond.

Psilochorus papago Gertsch. Twelve males were taken from June through December, except in September. Seven females were taken in June, July, and October, and two immatures in June. One spider was taken adjacent to the pond at Cane Springs.

Psilochorus utahensis Chamberlin. A total of 450 males was taken representing every month of the year except February. They were most common during June, July, and August. A total of 499 females was collected over all the months of the year except March. They were most common also during June, July, and August. The total immatures collected was 1500, and they were found during every month of the year, mostly during the same months as the adults, as well as in September. Two specimens were taken adjacent to the pond at Cane Springs.

Plectreuridae

Kibramoa paiuta Gertsch. One male was collected in May.

Plectreurys tristis Simon. One male was taken in May, and seven immatures in January, April, June, July, and September.

Salticidae

Metacyrba arizonensis Barnes. Thirteen males were collected during May and June, seven females in May, July, and November, and 16 immatures from April through October. Two specimens were taken adjacent to the Cane Springs pond.

Metacyrba taeniola Hentz. One male was taken in June, and two immatures in September.

Pellenes brunneus Peckham. One male was collected in October.

Pellenes hirsutus Peckham and Peckham. One female was taken during July.

Pellenes limatus Peckham. One male was collected in June.

Pellenes oregonensis Peckham and Peckham. Three males were taken during July and August, and one female in July.

Phidippus apacheanus Chamberlin and Gertsch. One male was collected in September.

Phidippus formosus Peckham and Peckham. Three males were taken in March and June, one female in February, and seven immatures in July, August, and September. Two spiders were taken adjacent to the pond at Cane Springs.

Phidippus opifex McCook. One male was found in August.

Phidippus workmanni Peckham and Peckham. Twenty-seven immatures were taken during June, July, and August. Two were taken near the pond at Cane Springs.

Scytodidae

Loxosceles unicolor Keyserling. Twenty-one males were taken from April through August and in October. Twelve females were collected in July, August, September, and November. Twenty-seven immatures were taken from May through October. Four specimens were taken adjacent to the pond at Cane Springs.

Theraphosidae

Aphonopelma sp. Twenty-four males were taken from August through November, and two females in June.

Theridiidae

Enoplognatha joshua Chamberlin and Ivie. Twenty-nine males were collected in February and March; 21 females from February through May; and 15 immatures in January, February, March, and October. One specimen was taken near the pond at Cane Springs.

Euryopis scriptipes Banks. One female was found in June.

Euryopis spinigera Cambridge. Two females were taken in April and June.

Latrodectus mactans Fabricius. Four males were taken in April, May, July, and December; 10 females in April, June, July, and December; and 28 immatures from July through January.

Steatoda fulva Keyserling. Twelve males were found from May through September; five females in February, August, and September; and nine immatures from May through September.

Steatoda medialis (Banks). One female was taken in July, and one immature in June.

Steatoda washona Gertsch. Two females were found during August.

Theridion sp. One immature was taken in July.

Thomisidae

Ebo dispar Schick. Three males were taken in October and December, and five females during October, November, and December.

Ebo merkeli Schick. One female and two immatures were taken in July.

Ebo mexicanus Banks. One female was taken in May.

Misumenops desertus Schick. One male was taken in August, and six immatures in August and October. One spider was taken near the Cane Springs pond.

Misumenops rothi Schick. Eight males were collected in June and July, 13 females in May, June, and July, and 16 immatures in June, July, and October. Ten spiders were taken near the Cane Springs pond.

Philodromus infuscatus Keyserling. One immature was found in July.

Rhysodromus clarus Keyserling. Fifteen immatures were taken in July.

Thanatus texanus Banks. Fourteen males were found from April through August, eight females in May and from July through November, and eight immatures from June through November, except during September.

Xysticus californicus Keyserling. One male was taken in May.

Xysticus iviei Schick. One female was found in June.

Xysticus lassanus Chamberlin. Eight males were collected in January, March, April, May, and September. Nine females were taken in February, April, May, June, September, and December. Twenty-seven immatures were taken from May through November.

Uloboridae

Uloborus diversus Marx. Three females were taken in August.

Summary

During the years 1959-1965, more than 5600 spiders were collected in connection with other studies at the Nevada Test Site. These represent 94 species of 65 genera in 22 families, not counting approximately 17 new species not reported here. The greatest numbers of species were found during June and July (Fig. 1), and populations of spiders were highest from June through September (Fig. 2). The Coleogyne and Mixed communities supported the greatest numbers of species, and the Coleogyne and Salsola communities possessed the highest populations (Table 2). Fewest species were found in the

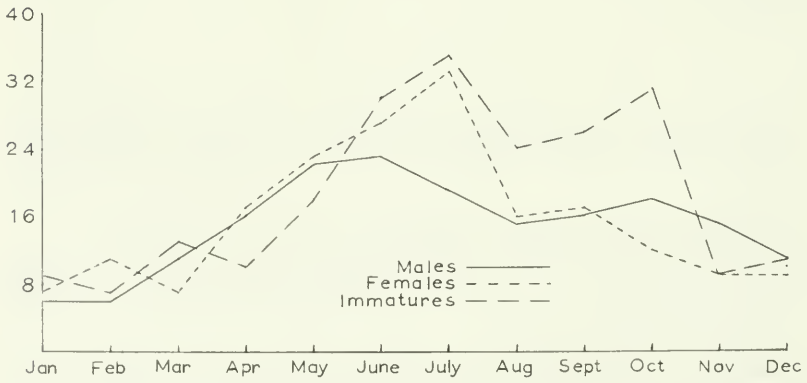


Fig. 1. Seasonal representation showing number of species present at the Nevada Test Site, 1959-1965.

Table 1. Frequency of occurrence[1] of spiders in seven plant communities and other habitats at the Nevada Test Site, 1959-1965.

Family and Species	Plant Community[2]								
	At-Ko	Co	Gr-Ly	La-Fr	Mixed	Pi-Ju	Sa	Other & Unknown	C S Pond Veg.
Agelenidae									
Agelenopsis aperta		*	*		*			*	*
Calilena restricta	1	3	4	7	6	2	5	*	
Circurlina utahana			*		*	*			
Argiopidae									
Apollophanes texana				*			*	*	*
Metepeira gosoga		2	3	2	2	1		*	
Tetragnatha laboriosa								*	
Caponiidae									
Orthonops gertschi		1	3	4	3		2		
Tarsonops sp.		*			*				
Clubionidae									
Anyphaena sp.	*								
Castianeira sp.			*						
Corinna bicalcarata		*	*	*	*				
Micaria gosiuta	2	3	4				1		
Neoanagraphis chamberlini	4	1	6	3	7	5	2		*
N. pearcei		2	5	3	1		4		
Phrurtimpus sp.						*			
Piabuna nanna			*						
Syspira eclectica	5	2	7	1	3	4	6	*	*
Dictynidae									
Dictyna calcarata								*	*
D. personata			*			*		*	

Table 1, Continued

Family and Species	Plant Community								
	At-Ko	Co	Gr-Ly	La-Fr	Mixed	Pi-Ju	Sa	Other & Unknown	C S Pond Veg.
D. reticulata					*	*			1
D. tucsona		*				*			
Mallos pallidus									*
Diguetidae									
Diguetia canities		*						*	*
D. signata				*					
Filistatidae									
Filistata utahana	*	*			*				
Gnaphosidae									
Cesonia classica		1		2	3				*
Drassodes celes	*								
Drassyllus fractus					*				
D. irritans	3	1	7	4	5	2	6		
D. moronius		*	*		*		*		
Gnaphosa californica	*	*			*	*	*		
G. hirsutipes	3	1	6	5	6	4	2		
Haplodrassus eunis	5	1	6	3	4	2	5		
Herpyllus hesperolus	4	1	6	5	3		2	*	*
Megamyrmecion naturalisticum		1		2	3				
Nodocion utus	*			*			*		
Zelotes monachus	5	1	4		3	2	6		
Z. nannodes	*								
Z. puritanus	*								

Table 1, Continued

Family and Species	Plant Community								
	At-Ko	Co	Gr-Ly	La-Fr	Mixed	Pi-Ju	Sa	Other & Unknown	C S Pond Veg.
Heteropodidae									
Olios fasciculatus	*				*				
Homalonychidae									
Homalonychus theologus		*		*	*				
Linyphiidae									
Ceratinopsis sp.		*							
Cochlembolus sanctus		*						*	1
Erigone dentosa					*				
Meioneta fillmorana				*	*				
M. formica					*				
Meioneta sp. nr. *fratrella*		*	*						
Spirembolus sp.									*
Tapinocyba sp.					*				
Lycosidae									
Alopecosa kochi		*	*	*			*		
Geolycosa rafaelana							*		*
Pardosa ramulosa									
Schizocosa sp.									
Tarentula kochi	6	2	5	4	3	1	5		
Mimetidae									
Mimetus eutypus									*
Oxyopidae									
Oxyopes tridens		4	5	1	3	2			

Table 1, Continued

Family and Species	Plant Community								
	At-Ko	Co	Gr-Ly	La-Fr	Mixed	Pi-Ju	Sa	Other & Unknown	C S Pond Veg.
Pholcidae									
Physocyclus tanneri	*	*	*		*				*
Psilochorus papago		2			3	1		*	*
P. utahensis	5	2	6	3	7	4	1	*	*
Plectreuridae									
Kibramoa paiuta					*				
Plectreurys tristis		*		*	*				
Salticidae									
Metacyrba arizonensis	3	2	3	2	3		1		*
M. taeniola		*					*		
Pellenes brunneus					*				
P. hirsutus		*							
P. limatus				*					
P. oregonensis						*			
Phidippus apacheanus		*							
P. formosus		1	3		2				*
P. opifex	*								
P. workmanni		2		1	2				*
Scytodidae									
Loxosceles unicolor		1	4	3	2			*	*
Theraphosidae									
Aphonopelma sp.	3	2	4	1	5		4		
Theridiidae									
Enophognatha joshua	3	1	6	4	2		5		*

Table 1, Continued

Family and Species	Plant Community								
	At-Ko	Co	Gr-Ly	La-Fr	Mixed	Pi-Ju	Sa	Other & Unknown	C S Pond Veg.
Euryopis scriptipes						*			
E. spinigera					*				
Latrodectus mactans	2		4		3		1	*	
Steatoda fulva		3	4	4		2	1		
S. medialis				*					
S. washona		*							
Theridion sp.						*			
Thomisidae									
Ebo dispar		*	*		*				
E. merkeli					*				
E. mexicanus							*		
Misumenops desertus				*					*
M. rothi		3		2	4	1			*
Philodromus infuscatus						*			
Rhysodromus clarus		1		2					
Thanatus texanus	3	1	4	3	2				
Xysticus californicus							*		
X. iviei						*			
X. lassanus		1	4	1	3	2	4		
Uloboridae									
Uloborus diversus		*							

[1]One equals most frequent. Sequence based on number collected proportionate to number of collecting attempts. * = insufficient numbers to compare.

[2]At-Ko = *Atriplex confertifolia* and *Kochia americana*; Co = *Coleogyne ramosissima*; Gr-Ly = *Grayia spinosa* and *Lycium andersonii*; La-Fr = *Larrea divaricata* and *Franseria dumosa*; Mixed = A variety of plants which occur in amounts which make assignment to one of the major communities impractical; Pi-Ju = *Pinus monophylla* and *Juniperus osteosperma*; Sa = *Salsola kali*. CS Pond Veg. = Vegetation adjacent to pond at Cane Springs.

Table 2. Number of species and relative abundance[1] of spiders found in seven plant communities[2] at the Neveda Test Site, 1959-1965.

	At-Ko	Co	Gr-Ly	La-Fr	Mixed	Pi-Ju	Sa
Number of species	26	50	35	36	49	26	28
Relative abundance of individuals	2.56 X	10.34 X	1.00	4.53 X	2.29 X	5.6 X	10.94 X

[1]The number given is in proportion to the minimum number found in the Grayia-Lycium community.
[2]At-Ko = *Atriplex confertifolia* and *Kochia americana*; Co = *Coleogyne ramosissima*; Gr-Ly = *Grayia spinosa* and *Lycium andersonii*; La-Fr = *Larrea divaricata* and *Franseria dumosa*; Mixed = A variety of plants which occur in amounts which make assignment to one of the major communities impractical; Pi-Ju = *Pinus monophylla* and *Juniperus osteosperma*; Sa = *Salsola kali*.

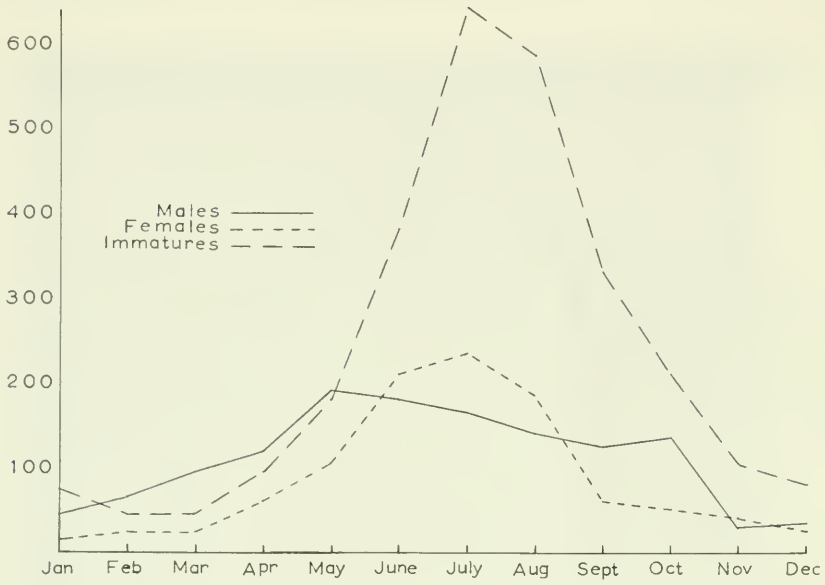


Fig. 2. Seasonal abundance of spiders (all species) at the Nevada Test Site, based on total numbers of individuals collected, 1959-1965.

Pinyon-Juniper community, and lowest populations in the Grayia-Lycium (Table 2).

Eight species were found in each of the seven plant communities, and were widely distributed at the test site. These are *Calilena restricta*, *Drassyllus irritans*, *Gnaphosa hirsutipes*, *Haplodrassus eunis*, *Neoanagraphis chamberlini*, *Psilochorus utahensis*, *Syspira eclectica*, and *Tarentula kochi*. *Psilochorus utahensis* was by far the most abundant in numbers of individuals, followed by *S. eclectica*, *H. eunis*, and *T. kochi*. *Haplocrassus eunis*, *P. utahensis*, and *T. kochi* were the most abundant in numbers of individuals during all 12 months of the year.

References

Allred, D. M., D E. Beck, and C. D. Jorgensen. 1963. Biotic communities of the Nevada Test Site. Brigham Young University Sci. Bull., Biol. Ser., 2(2):1-52.

Allred, D. M., and D E. Beck. 1964. Arthropod associates of plants at the Nevada Test Site, Brigham Young Univ. Sci. Bull., Biol. Ser., 5(2):1-16.

Comstock, J. H. (revised and edited by W. J. Gertsch). 1948. The spider book. Comstock Publ. Assoc., Ithaca.

PROBLEMS OF SAMPLING DESERT ARTHROPODS BEFORE AND AFTER A THERMONUCLEAR CRATERING TEST

Clayton S. Gist[1]

Introduction

On July 6, 1962, the U. S. Atomic Energy Commission detonated a large thermonuclear device at the Nevada Test Site (Project Sedan). The device was buried 635 feet underground and had a total yield of 100±15 kilotons. The explosion ejected about 7.5 million yards of alluvium and produced a crater 320 feet deep and 1200 feet in diameter (Fig. 1). The ejected alluvium was radioactive, and gamma intensities of several hundred milliroentgens/hour persisted for months within a mile of ground zero. After a year, gamma intensities at the edge of the crater were still about 15 mr/hour.

Some of the effects of this test on plants and animals in areas near ground zero have already been reported (Allred *et al.* 1964, Jorgensen *et al.* 1963, Martin 1963, and Turner and Gist 1965). One feature of the biological studies was an analysis of selected arthropods near ground zero before and after the test. The study was restricted to species which could be sampled readily with sunken can traps, and which were known to be well represented in the test area. I sought evidence of possible changes in species composition, or in relative abundance of species as a result of the test. These factors might influence the long-term recovery of the close-in area, or indirectly affect the survival of vertebrates in these areas.

The area selected for the test was 4317 feet above sea level and located at the north end of Yucca Flat. This desert basin is about 15 miles long and 10 miles wide, in the northern portion of the Nevada Test Site. Floristically it is part of the broad transition between the Mojave Desert and Great Basin (Beatley 1962). The area in the vicinity of ground zero had been used for testing in the past and much of the native vegetation had been destroyed and replaced by Russian thistle (*Salsola kali*) and stick-leaf (*Mentzelia veatchiana*). However, to the northeast of ground zero—at least beyond 3000 feet—the vegetation in 1962 was relatively undisturbed (Fig. 2) and composed predominantly of shrubs, *e.g.*, hopsage (*Grayia spinosa*) and blackbrush (*Coleogyne ramosissima*). Studies of arthropods were centered in this area.

Methods and Results

Two study plots were established along a line running from ground zero to 10,000 feet on a grid azimuth of 58°. Between 3530 and 3800 feet, a 10 x 10 grid of 100 buried can traps was established

1. Laboratory of Nuclear Medicine and Radiation Biology, UCLA School of Medicine, Los Angeles, California 90024.

Fig. 1 View of Sedan crater on Yucca Flat at the Nevada Test Site. Truck and monitors may be seen in left foreground.

on June 21 (Fig. 3). The traps were 30 feet apart and the grid was centered on the surveyed line. A similar grid was set up between 8730 and 9000 feet on June 23. The area of such grids was about 72,900 square feet (1.7 acres) in extent. The cans were 6.9 inches deep and 6.3 inches in diameter. All traps were covered with a square foot of masonite with one-inch legs at each corner. Except for June 27, when a small device was exploded on Yucca Flat, the traps in both grids were examined daily between June 22 and July 5. Live arthropods were removed from the traps, recorded, and released beneath the nearest bush so as to prevent unnatural losses due to predation. Dead animals were recorded and discarded. Traps were sealed on the afternoon of July 5, and remained closed until radiation intensities in the study area had declined to a safe level. Sampling was resumed on July 30, 24 days after the test, and continued for two weeks during August.

In June 1963 a new grid of 100 can traps was established between 4730 and 5000 feet from ground zero on the line described above. This new grid of traps, along with the two grids at 3800 and 9000 feet, was sampled daily between June 10 and June 28.

The arthropods recorded were common species (or species groups) which could be distinguished in the field. If errors in identification occurred they were probably in attempting to discriminate between species of young scorpions and between *Eleodes hispilabris* and other beetles of this genus.

The results of the sampling are given in Table 1.

Discussion

The interpretation of the numbers in Table 1 is uncertain for the following reasons. Small differences in the numbers of individuals captured do not necessarily imply real differences in abundance. Thus, when small numbers are involved, even relatively "large" differences are probably insignificant. Without repeated trapping in the same area, preferably by means of replicated grids in identical habitats, there is no way to assess the significance of such data except intuitively. The problem is first to identify any real differences suggested by the data, and then to determine whether these are related to the Sedan test.

The tenebrionid beetle, *Pelecyphorus pantex*, can be eliminated from further consideration. Its absence from traps during June, and its presence during August, is a seasonal activity effect unrelated to the Sedan test (see Allred *et al.* 1963). Secondly, the area at 9000 feet was not comparable to that at 3800 feet. Not only did the vegetation differ (see Jorgensen *et al.* 1963), but also the substratum at 9000 feet was desert pavement, while at 3800 feet it was sandy. The number of arthropods captured at 9000 feet was invariably less than that taken at 3800 feet.

The data based on samples taken at 9000 feet do not suggest any changes associated with the test. In fact, probably the only significant

Fig. 2. Northern portion of Yucca Flat looking northeast on June 21, 1962. Marker is 5000 feet from drilling site.

Table 1. Captures of arthropods in grids of 100 traps before and after the Sedan test of July 6, 1962.

Species	3800 feet			5000 feet		9000 feet	
	June 1962 (14)[1]	August 1962 (14)	June 1963 (18)	June 1963 (18)	June 1962 (12)	August 1962 (12)	June 1963 (18)
Scorpions							
Vejovis confusus Stahnke	28	106	40	60	19	22	10
Hadrurus hirsutus Wood	11	43	2	14	5	14	14
Orthopterans							
Arenivaga apacha (Saussure)	2	16	0	8	2	4	1
Stenopelmatus fuscus Thomas	76	19	97	225	3	0	0
Ceuthophilus spp.	16	6	2	4	5	6	0
Tenebrionid beetles							
Trogloderus costatus LeConte	20	91	122	144	6	1	5
Eleodes hispilabris (Say)	11	31	6	5	8	8	3
Pelecyphorus pantex Casey	0	532	0	0	0	6	0
Eleodes spp. (mostly *E. armata* LeConte)	40	20	0	2	18	9	0

[1]Number of days traps were examined.

difference between June of 1962 and 1963 was the failure to capture beetles of the genus *Eleodes* (except *E. hispilabris*) in 1963. The numbers of these beetles apparently declined at 3800 feet also but I do not believe the Sedan test was responsible. Other investigations have indicated that, except for the deposition of radioactive dust, there were no demonstrable effects of the Sedan test at 9000 feet (Martin 1963, Jorgensen *et al.* 1963, Turner and Gist 1965).

The remaining comparisons involve samples taken at 3800 feet at different times, and samples taken at 3800 and 5000 feet in June 1963. The 1962 samples at 3800 feet showed considerable differences in the numbers of arthropods captured. I believe it reasonable to assert that changes in numbers of certain species, or changes in susceptibility to capture, occurred between June and August. The increase in scorpions was due to the appearance of young animals in the traps, and is what would have been expected on the basis of earlier work by Allred *et al.* (1963). *Arenivaga apacha*, *Trogloderus costatus*, and *E. hispilabris* were captured in what were probably significantly larger numbers, but the causes for this increase are not known. On the other hand, the number of *Stenopelmatus fuscus*

Fig. 3. Yucca Flat looking northeast on June 21, 1962. Marker is 3500 feet from drilling site.

captured decreased sharply, and there may have been a significant drop in the number of camel crickets (*Ceuthophilus* spp.) captured. However, I discern no patterns in these events implicating the Sedan test.

In June of 1963 there were also indications of change at 3800 feet. The sampling time was about 30% longer in 1963 (18 days *vs.* 14 days), so some increase might be expected for this reason alone (*e.g.*, *Stenopelmatus*, *Vejovis*). However, the much greater abundance of *Trogloderus* cannot be explained on this basis. Furthermore, the samples contained fewer *Hadrurus*, *Ceuthophilus* and *Eleodes hispilabris*, and no other *Eleodes*. The apparent decline in numbers of *Eleodes* (other than *E. hispilabris*) has already been discussed. It is surprising that some arthropods (*e.g.*, *Stenopelmatus*, *Trogloderus*, and *Vejovis*) persisted so successfully in an area subjected to such devastation (Fig. 4). One might conjecture that herbivorous species would be extremely sensitive to the sort of disruption experienced at 3800 feet. On the other hand, carnivorous and omnivorous species would, at least for a time, have some available food. The apparent decline of the large carnivorous *Hadrurus hirsutus* may in some way be related to the extensive destruction of surface cover. Both *Stenopelmatus fuscus* and *Vejovis confusus* are carnivorous. *Trogloderus costatus* is probably omnivorous. The plant feeders (*Arenivaga apacha* and *Ceuthophilus* spp.) at least showed no signs of increasing at 3800 feet.

During June of 1963, more arthropods were captured at 5000 feet than at 3800 feet. Prior to the Sedan test these two areas were similar in terms of soils and vegetation but I have no pre-test arthropod data from 5000 feet. However, I believe that the greater numbers of arthropods taken at 5000 feet during June 1963 reflect better survival in this area. This is not surprising in view of the relative destruction at 3800 feet (Fig. 4) and at 5000 feet (Fig. 5). In short, except for the reduction in numbers of arthropods at 3800 feet compared to 5000 feet, I perceive no short-term test-related effects in the data in Table 1.

There is no clear-cut relationship between apparent changes in numbers and food habits, although there is a possibility that carnivorous or omnivorous forms persist more successfully than herbivorous ones in the areas where the above-ground vegetation is largely destroyed. If there were close-in effects, it is possible that they could have occurred because of destruction or modification of habitat, and not because of ionizing radiation.

Probably the most significant lesson which emerges from the above experience is that deducing real changes in arthropod populations on the basis of captures in traps is difficult, and requires a considerable sampling effort in order to avoid ascribing significance to differences which have occurred simply due to chance. There is also the difficulty of *seasonal variation* touched on indirectly in this paper, and treated in detail for the Nevada Test Site by Allred *et al.*

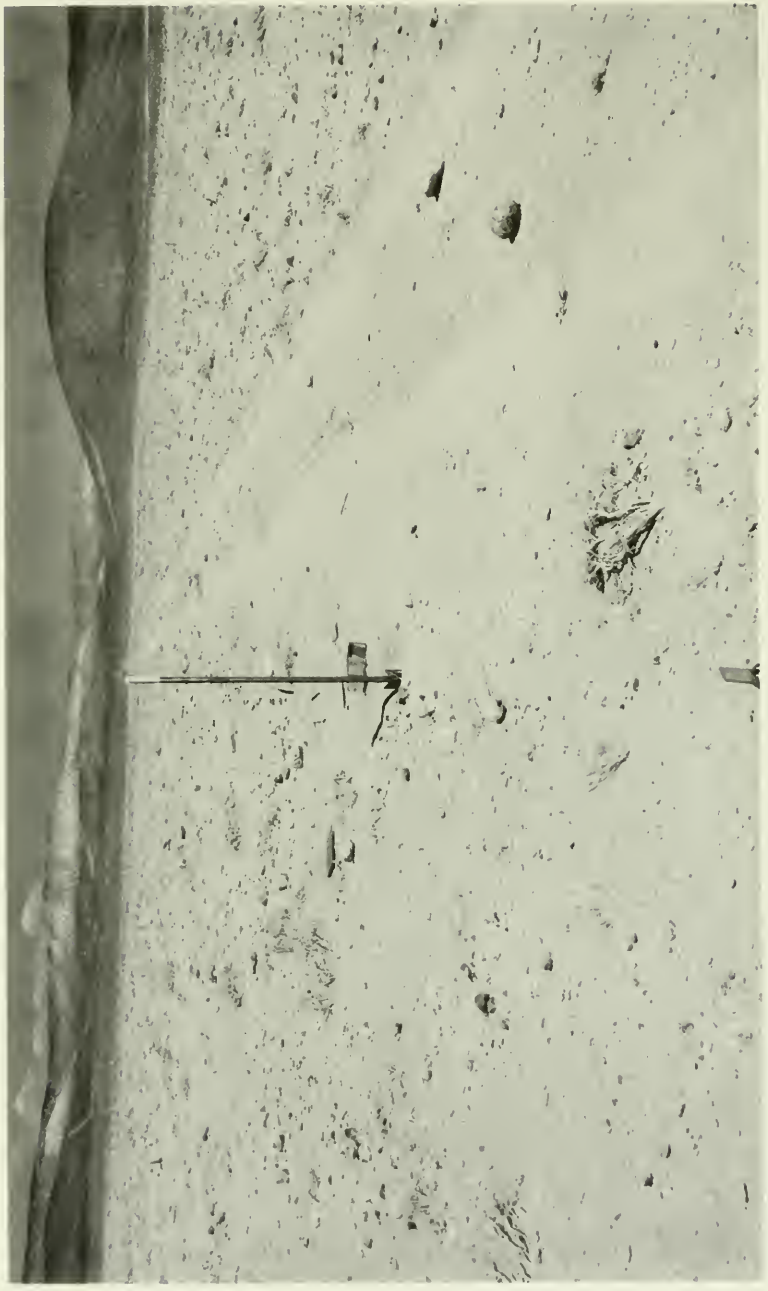


Fig. 4. Yucca Flat looking northeast on August 23, 1962. Marker is 3500 feet from ground zero. Compare with Fig. 3.

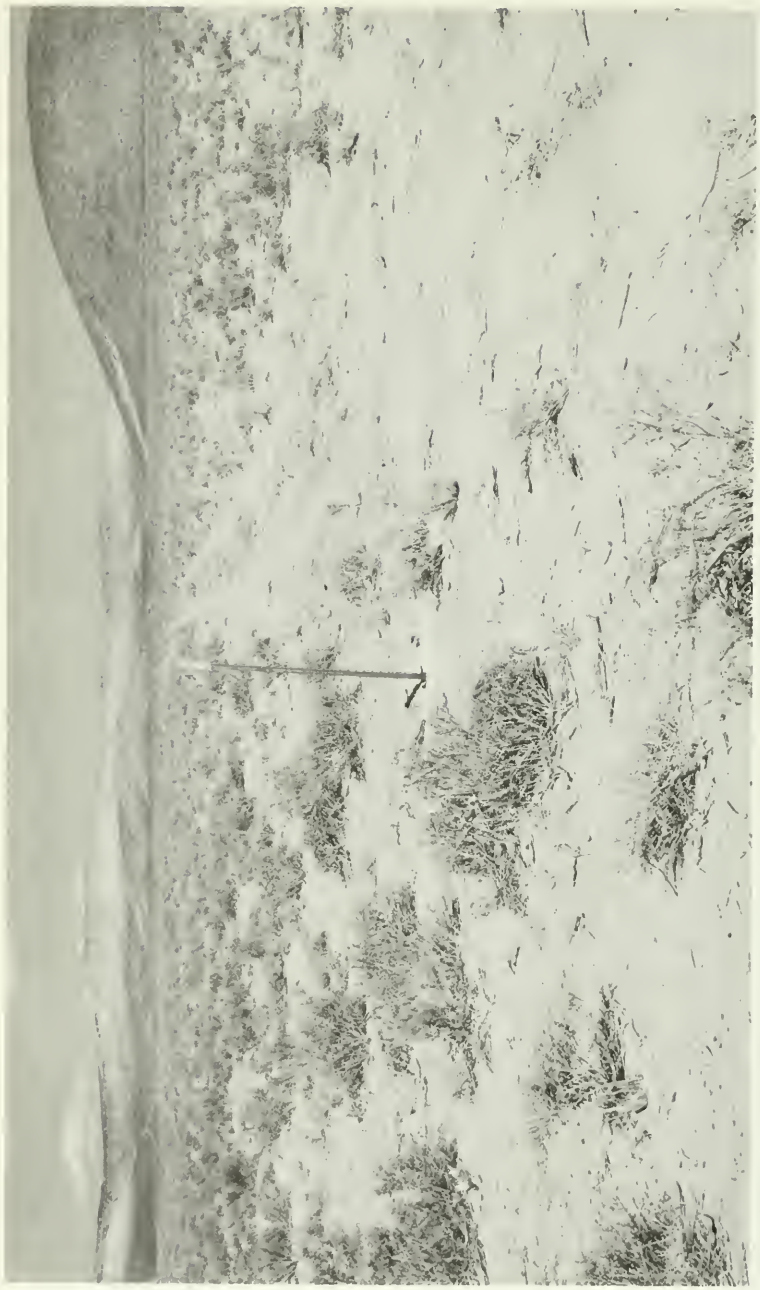


Fig. 5. Yucca Flat looking northeast on August 23, 1962. Marker is 5000 feet from ground zero. Compare with Fig. 2.

(1963). Examining the records of several consecutive years does not always guarantee the ability to evaluate the observations in some future year, because no two years are precisely equivalent. Finally, even if statistics and/or intuition suggest that the sampling reflects true changes in numbers, the causes for such changes are apt to be extremely elusive. With so many factors governing the numbers of arthropods captured, it is almost impossible to pinpoint effects due to some specific cause, unless there are across-the-board changes obviously attributable to this particular influence.

ACKNOWLEDGMENTS. Original reference material was generously supplied by Dorald Allred of Brigham Young University, and one subsequent identification was made by Vasco M. Tanner of the same institution. I thank Frederick Turner of the University of California, Los Angeles, and Vernon Stern, of the University of California, Riverside, for useful criticisms and suggestions. I also thank John Williamson, Civil Effects Test Organization coordinator, for the many services without which this work could not have been accomplished. These studies were supported by Contract AT(04-1) GEN-12 between the Atomic Energy Commission and the University of California at Los Angeles.

LITERATURE CITED

ALLRED, D. M., D ELDEN BECK, AND C. D. JORGENSEN. 1963. Biotic communities of the Nevada Test Site. Brigham Young Univ. Sci. Bull., Biol Series, Vol. 2, 52 pp.

———. 1964. Close-in effects of an underground nuclear detonation on small mammals and selected invertebrates. U. S. Atomic Energy Commission Report PNE-226F, 22 pp.

BEATLEY, J. C. 1962. Vascular plants of the U. S. Atomic Energy Commission's Nevada Test Site, Nye County, Nevada, U. S. Atomic Energy Commission Report UCLA 508, 33 pp.

JORGENSEN, C. D., D. M. ALLRED, AND D ELDEN BECK. 1963. Some effects of an underground nuclear detonation on biotic communities at the Nevada Test Site. Proc. Utah Acad. Sci., Arts, and Letters, 40:49-61.

MARTIN, W. E. 1963. Close-in effects of an underground nuclear detonation on vegetation. I. Immediate effects of cratering, throw-out, and blast. U. S. Atomic Energy Commission Report PNE-228P, 45 pp.

TURNER, F. B., AND C. S. GIST. 1965. Influence of a thermonuclear cratering test on close-in populations of lizards. Ecology 46:845-852.

NEW SPECIES OF BARK BEETLES (COLEOPTERA: SCOLYTIDAE), MOSTLY MEXICAN PART VII[1]

Stephen L. Wood[2]

In order to make names available for other work, 21 species of Scolytidae are described on the following pages as new to science. Most of the species are from Mexico, although four species occur in Honduras; three of these four are common to both areas. The genera represented include: *Hylastes* (1), *Pseudothysanoes* (1), *Cactopinus* (1), *Pityophthorus* (3), *Pseudopityophthorus* (4), *Gnathotrichus* (4), *Monarthrum* (3), *Microcorthylus* (1), *Amphicranus* (2), and *Corthylus* (1).

Most of the specimens were collected either by Dr. J. B. Thomas, Canada Department of Forestry, or by myself. The type material is mostly either in the Canadian National Collection or my collection, except for a few paratypes in the California Academy of Sciences.

Hylastes mexicanus, n. sp.

This species is more closely allied to *nitidus* Blackman than to other known species, but it has the sides of the pronotum much more strongly arcuate and the pronotal surface much more finely punctured.

Female.—Length 4.5 mm. (paratypes 4.3-4.5 mm.), 2.8 times as long as wide; color black.

Frons convex, with a weak, transverse impression between eyes and more strongly impressed just above epistoma; median carina inconspicuous, more strongly elevated below, continuing dorsad as a fine line to interocular impression; surface smooth and shining above, rather dull below, very finely, deeply, closely punctured; vestiture minute, inconspicuous, covering entire surface.

Pronotum 1.1 times as long as wide; sides widest on basal third, but almost parallel to a point just anterior to middle then broadly, evenly rounded to anterior margin, appearing much wider than in *nitidus;* surface smooth and shining, with punctures fine, deep, close, separated by distances about equal to their own diameters; glabrous.

Elytra 1.9 times as long as wide, 1.9 times as long as pronotum; sides straight and subparallel on basal half, then increasingly arcuate to the rather narrowly rounded posterior margin; striae 1 moderately, others weakly impressed, the punctures small, deep; interstriae as wide as striae, feebly convex, subshining, the punctures rather coarse, close, deep, confused, their diameters slightly greater

1. In part, field work for the study in which these species were collected was sponsored by grants from the National Science Foundation Nos. GB-532 and GB-3678.

2. Department of Zoology and Entomology, Brigham Young University, Provo, Utah. Scolytoidea Contribution No. 30.

than half those of striae. Vestiture confined to declivity, stout, almost scalelike except for median rows of equally short bristles on each interspace.

MALE.—Similar to female except frons narrower and fifth visible sternum longitudinally impressed and pubescent.

TYPE LOCALITY.—Forty miles west of Toluca, Mexico, Mexico.

HOST.—*Pinus* sp.

TYPE MATERIAL.—The female holotype, male allotype and three paratypes were taken at the type locality on July 15, 1953, at an elevation of 7,900 feet, from the base of a pine about 14 inches in diameter, by S. L. Wood. In addition, 64 paratypes were taken 10 miles west of El Salto, Durango, Mexico, during July 1964, in flight, by J. B. Thomas.

The holotype, allotype and some of the paratypes are in my collection, other paratypes are in the Canadian National Collection.

Cactopinus mexicanus, n. sp.

Although not very closely related, this species is more nearly like *hubbardi* Schwarz than other species. It may be readily separated by the stouter body, by the tuberculate elytral interspaces, by the much steeper, more deeply sulcate elytral declivity, and, in the male, by the shorter, widely separated frontal horns.

MALE.—Length 1.6 mm. (paratypes 1.3-1.6 mm.), 2.1 times as long as wide; color black.

Frons deeply excavated from eye to eye and from epistoma to vertex, the margin at vertex rather sharp; epistoma armed by two long, tapered spines, each about equal in width at base to one-fourth width of epistoma and in length to distance between epistoma and vertex, the spines separated at bases by a distance equal to basal width of one spine; spines and margin of excavation bearing a few rather coarse, hairlike setae. Eye oval, entire. Antennal club subcircular, the sutures bisinuate, marked by rows of setae.

Pronotum wider than long; widest at base, sides rather strongly arcuate on basal half, strongly constricted behind the rather narrowly rounded anterior margin; summit well behind middle, its elevation continuing behind basal margin, ending posteriorly in a single projecting cusp; surface rather coarsely punctured, each puncture with a large granule or small asperity on its anterior or lateral margin, those toward summit slightly larger; vestiture scanty, hairlike.

Elytra 1.2 times as long as wide; sides weakly arcuate to base of declivity, then more strongly rounded to lateral elevations of declivity, deeply, rather broadly emarginate behind; striae not impressed, coarsely, very deeply punctured; interstriae about as wide as striae, the punctures in uniseriate rows, about one-third as large as those of striae, deep, each armed on its posterior margin by a high, pointed or rounded tubercle from base to apex. Declivity rounded, vertical, deeply sulcate; interspace 1 moderately raised, striae 1 im-

pressed; lateral areas elevated, the summit reached near middle of declivity on interspaces 3 and 4.

FEMALE.—Similar to male except frons shallowly impressed, epistoma unarmed, and general sculpture finer.

TYPE LOCALITY.—Thirteen miles north of Juchitlan, Jalisco, Mexico.

HOST.—Giant cactus.

TYPE MATERIAL.—The male holotype, female allotype and 112 paratypes were taken at the type locality on July 2, 1965, at an elevation of 3,000 feet, by S. L. Wood, from just under the epidermis of a dying giant cactus.

The holotype, allotype and paratypes are in my collection.

Pseudothysanoes thomasi, n. sp.

This species is unique among described species in the genus. The male has a prominent declivital elevation on the third interspaces that ends abruptly just below the middle of the declivity. The female declivity is simple as in other species of the genus.

MALE.—Length 1.1 mm., 2.5 times as long as wide; body color light brown.

Frons broad, weakly convex below upper level of eyes, with epistomal area distinctly elevated, more strongly convex above eyes; surface rugulose and with a small, rounded granule at base of each seta; vestiture consisting of moderately long and abundant fimbriate setae, those above directed dorsad, those on epistoma directed orad. Antennal scape short, subcircular, scarcely longer than pedicle, club 1.4 times as long as wide; pubescent, with sutures indistinctly indicated.

Pronotum 0.94 times as long as wide; sides strongly arcuate, widest just behind middle; summit distinct, the asperites moderately large; anterior margin armed by eight coarse, basally separate teeth; surface behind summit minutely reticulate, with a few small, rounded, squamiferous granules; vestiture consisting of semierect scales and a few inconspicuous bristles.

Elytra about 1.5 times as long as wide; sides straight and subparallel on basal two-thirds, rather broadly rounded behind; striae feebly impressed, the punctures minute and distinguished with difficulty from those of interstriae; interstriae subrugose, the punctures indistinct. Declivity convex, moderately steep; interspace 2 strongly narrowed below, interspace 3 with a large unarmed elevation extending about two-thirds the length of declivity from base, ending abruptly below, its base as wide as interspaces 1 and 2 combined, its height slightly less than its basal width. Vestiture consisting of rows of short, recumbent, strial, hairlike setae, and slightly longer scalelike setae, each scale on posterior half at least as wide as long.

FEMALE.—Similar to male except frons more strongly impressed, strial punctures more strongly impressed, elytral declivity devoid of

elevation, interspace 2 almost normal, and elytral scales slightly more slender.

TYPE LOCALITY.—Mazatlan, Sinaloa, Mexico.

TYPE MATERIAL.—The male holotype, female allotype and seven paratypes were taken at the type locality, evidently in August 1964, from an unidentified tree by J. B. Thomas.

The holotype, allotype and part of the paratypes are in the Canadian National Collection, other paratypes are in my collection.

Pityophthorus festus, n. sp.

This species is closely related to *ponderosae* Blackman, but is easily distinguished by the regular striae on the basal half of the elytra, by the more narrowly rounded elytral declivity, and by the smaller average size.

MALE.—Length 1.4 mm. (paratypes 1.3-1.5 mm.), 2.6 times as long as wide; color dark brown.

Frons convex; epistoma broadly emarginate; surface coarsely, deeply punctured, a sharply elevated, rather prominent median carina of almost uniform height extending from just above upper level of eyes to espistomal margin; vestiture sparse, inconspicuous except on epistomal margin. Antenna as in *ponedrosae*.

Pronotum equal in length and width; widest on basal third, the sides weakly arcuate and converging to weak constriction just behind narrowly rounded anterior margin; anterior margin armed by eight small teeth; summit at middle, moderately impressed behind; posterior area rather coarsely, deeply, closely punctured; vestiture short, sparse, inconspicuous.

Elytra 1.7 times as long as wide; sides straight and subparallel on more than basal two-thirds, rather narrowly rounded behind; striae in definite rows to base, the punctures small, rather deep; interspaces flat, as wide as striae, marked by some surface lines, impunctate. Declivity narrowly bisulcate, moderately steep; declivital punctures largely obsolete; interspace 1 moderately elevated, unarmed, striae 1 sharply impressed, lateral area gradually raised and rounded with the summit at striae 3; interspace 3 with a few very minute granules; general surface almost smooth, shining. Vestiture hairlike, fine, short, sparse.

FEMALE.—Evidently indistinguishable from male except by segmentation of abdominal terga.

TYPE LOCALITY.—Eighteen miles west of El Salto, Durango, Mexico.

HOST.—*Pinus* sp. (type), *P. ayacahuite* and *leiophylla* (paratypes).

TYPE MATERIAL.—The male holotype, female allotype and two paratypes were collected at the type locality on June 3, 1965, from pine branches, at an elevation of 7,500 feet, by S. L. Wood; two other paratypes bear the same data but were taken 3 miles west of El Salto from *P. ayacahuite*. Four paratypes were taken 23 miles

west of Durango, Durango, on June 4, 1965, from *P. leiophylla;* five paratypes were taken 14 miles northwest of Guadalajara, Jalisco, on July 19, 1953, from pine branches, all by S. L. Wood. Four additional paratypes were collected 10 miles west of El Salto, Durango, during July 1964, by J. B. Thomas.

The holotype, allotype and some of the paratypes are in my collection, other paratypes are in the Canadian National Collection.

Pityophthorus foratus, n. sp.

Among described species this species is more closely related to *schwerdtfergeri* (Schedl) than to any other, but it is easily distinguished by the second declivital interspace which is almost twice as wide as in Schedl's species.

Female.—Length 2.5 mm. (paratypes 2.1-2.5 mm.), 2.5 times as long as wide; body color dark brown, the elytra a lighter brown.

Frons plano-convex from upper level of eyes to epistoma, rather coarsely, closely punctured; vestiture very fine, hairlike, moderate in length and abundance, as in *schwerdtfergeri.*

Pronotum very slightly wider than long; widest at base, sides weakly arcuate and converging toward the narrowly rounded anterior margin; anterior margin armed by about eight low teeth; summit at middle, definite; posterior area with rather coarse, close, deep punctures, surface not entirely smooth, shining; vestiture fine, inconspicuous.

Elytra 1.5 times as long as wide, 1.8 times as long as pronotum; sides straight and subparallel on basal three-fourths, abruptly, very broadly rounded behind; strial and interstrial punctures confused on basal half of disc, striae 1 impressed near declivity and punctures of 1 and 2 recognizable, rather small, deep; punctures of interspace 1 recognizable at base of declivity, slightly smaller than those of striae. Declivity flattened, steep; strial punctures reduced but distinct on all striae; interspace 1 narrow, moderately elevated, unarmed, 2 impressed, very broad, three times as wide as 1, subreticulate, impunctate, 3 very narrow, narrower than 1, summit of lateral elevation reached on 4, unarmed. Vestiture limited to sides, fine, hairlike, rather long.

Male.—Not represented in series at hand.

Type Locality.—Ten miles west of El Salto, Durango, Mexico.

Type Material.—The female holotype and six female paratypes were collected at the type locality during July, 1964, in flight in a pink-oak forest, at about 9,000 feet in elevation, by J. B. Thomas.

The holotype and some paratypes are in the Canadian National Collection, other paratypes are in my collection.

Pityophthorus quercinus, n. sp.

Among described species this species should be placed near *rhois* Swaine in Blackman's group II, although it is not closely related.

The much larger size and entirely different sculpturing of pronotum and elytral declivity distinguish it.

FEMALE.—Length 2.1 mm. (paratypes 1.8-2.2 mm.), 3.0 times as long as wide; color dark brown.

Frons broadly flattened from vertex to epistoma, with epistomal area slightly elevated, the lateral margins not sharply defined; surface closely, rather coarsely granulate-punctate and uniformly ornamented by moderately abundant, long, yellow hair of uniform length. Antennal club rather small, 1.2 times as long as wide; sutures 1 and 2 straight and septate, widest through segment 2, 1 and 3 about equal in width.

Pronotum 1.2 times as long as wide; sides on basal half straight and subparallel; anterior margin broadly rounded and armed by an indefinite row of basally fused teeth; summit in front of middle, indefinite; asperities on anterior area rather small, confused, not extending to base laterally; posterior area subshining, closely, deeply, rather finely punctured, and with numerous impressed points; disc glabrous.

Elytra 1.8 times as long as wide; sides straight and subparallel on more than basal two-thirds, rather narrowly rounded behind; striae 1 impressed to base, others feebly if at all impressed, the punctures rather small, deep, close; interspaces shining, weakly convex, impunctate but with rather abundant impressed points.

Declivity bisulcate, moderately steep; all striae with punctures distinctly impressed but slightly smaller than on disc; interspace 1 rather strongly elevated and armed by three widely spaced, moderately large, pointed granules, 2 impressed, flat, impunctate, 3 moderately elevated but not equal to 1, armed by a row of about seven rather large granules, lateral areas with punctures confused. Vestiture hairlike, confined to sides and to setiferous granules on declivity.

MALE.—Similar to female except frons convex, somewhat protuberant on upper half, more deeply, closely punctured, glabrous, and elytral declivity conspicuously deeper and wider, with striae obscure, the granules larger.

TYPE LOCALITY.—Three miles west of El Salto, Durango, Mexico.

HOST.—*Quercus* sp.

TYPE MATERIAL.—The female holotype, male allotype and 41 paratypes were taken at the type locality from the phloem tissues of the bole of a very large oak, on June 7, 1965, at an elevation of 7,500 feet by S. L. Wood. Twelve additional paratypes were collected at 33 miles east of Moralia, Michoacan, Mexico, on June 14, 1965, at an elevation of 9,000 feet, from the same oak, by S. L. Wood. Ten paratypes were also taken 10 miles west of El Salto, Durango, Mexico, during July 1964, from oak, by J. B. Thomas.

The holotype, allotype and some of the paratypes are in my collection; other paratypes are in the Canadian National Collection.

Pseudopityophthorus hondurensis, n. sp.

Using Blackman's (1931, J. Ent. Soc. Washington 21:225) key this species is placed near *agrifoliae* Blackman. However, it differs in frontal vestiture in both sexes and in lacking the short setae of striae and interstriae on the elytra.

Male.—Length 1.3 mm. (paratypes 1.2-1.6 mm.), about 2.8 times as long as wide; body color very dark brown, summit of pronotum somewhat lighter.

Frons plano-convex over a broad area, with a marginal fringe of long, yellow hair, the median area punctured. Antennal club widest through segment 3.

Pronotum 1.05 times as long as wide; sides straight and subparallel on basal half, then moderately constricted before the broadly rounded anterior margin; anterior margin armed by about 14 low teeth; summit poorly developed, at middle; posterior area smooth and shining, with rather sparse, coarse, deep punctures and more numerous minute points; almost glabrous.

Elytra 1.5 times as long as wide; sides approximately straight and parallel on basal two-thirds, almost semicircularly rounded behind; striae not impressed, the punctures, fine, distinct but not deep, in definite rows; interstriae almost flat, smooth and shining, with a few fine lines and impressed points. Declivity convex, moderately steep; strial punctures obsolete; interspaces except 2 with a few minute setiferous granules. Vestiture mostly confined to declivity, consisting of slender, erect, hairlike, interstrial setae.

Female.—Almost indistinguishable from male, but evidently with frontal vestiture less abundant and shorter.

Type Locality.—Buenos Aires, Cortes, Honduras.

Host.—*Quercus* sp.

Type Material.—The male holotype, female allotype and 28 paratypes were taken from a dying oak branch at the type locality on May 7, 1964, at an elevation of 7,000 feet by S. L. Wood.

The holotype, allotype and paratypes are in my collection.

Pseudopityophthorus granulifer, n. sp.

This species is closely related to *granulatus* Blackman, but it is much larger and has longer and more abundant frontal vestiture in both sexes.

Female.—Length 1.8 mm. (paratypes 1.6-2.0 mm.), 2.8 times as long as wide; color almost black.

Frons plano-convex over a broad area, with a dense marginal fringe of long, yellow hair as in the male of most species. Second and third segments of antennal club equal in width.

Pronotum 1.2 times as long as wide; sides gradually, arcuately narrowed toward the rather broadly rounded anterior margin; anterior margin armed by about 14 teeth; summit indefinite, at middle; posterior area smooth and shining, with fine, rather sparse, deep

punctures and more abundant minute points; vestiture limited to sides and asperate area.

Elytra 1.5 times as long as wide; sides almost straight and subparallel on basal two-thirds, rather narrowly rounded behind; striae 1 weakly impressed, the others not at all impressed, the punctures very small, shallow, in rather indefinite rows; interstriae obscure, with a few punctures, points and surface lines. Declivity convex, rather steep, with interspace 2 impressed; strial punctures obsolete; interspaces 1, 2 and 3 each armed by a row of rounded granules that decrease in size and number toward apex; declivital surface smooth, dull. Vestiture consisting of rather sparse, erect bristles arranged in fine strial and coarse interstrial rows; some interstrial bristles on declivity strongly flattened.

MALE.—Evidently exactly like the female, distinguishable only by segmentation of abdomen.

TYPE LOCALITY.—Zamorano, Morazan, Honduras.

HOSTS.—*Quercus sapotaefolia* (type), and *hondurensis* (paratype).

TYPE MATERIAL.—The female holotype, male allotype and 10 paratypes were taken from *Quercus sapotaefolia* and five paratypes from *Q. hondurensis* at the type locality on April 18, 1964, at an elevation of 2,200 feet, by S. L. Wood. One other paratype was taken in flight at Guatemala City, Guatemala, May 30, 1964. A specimen probably belonging to this species, but not designated as a paratype, was collected at San Cristobal de las Casas, Chiapas, Mexico, on July 5, 1956, by D. D. Linsdale.

The holotype, allotype and paratypes are in my collection.

Pseudopityophthorus tropicalis, n. sp.

This species evidently is allied to *pulvereus* Blackman, but is readily distinguished by the rows of erect declivital scales.

MALE.—Length 1.7 mm. (paratypes 1.5-1.7 mm.), 2.8 times as long as wide; color rather dark brown with white vestiture.

Frons plano-convex from eye to eye from vertex to epistoma, and ornamented at margins by a fringe of abundant, long, yellow hair, central area concealed in all males at hand. Antennal club elongate, about 1.5 times as long as wide, with segments 2 and 3 equal in width.

Pronotum 1.1 times as long as wide; widest at base, sides weakly arcuate and gradually narrowed anteriorly, weakly constricted just before anterior margin; anterior margin rather broadly rounded and armed by about 14 low teeth; summit indefinite; posterior area finely, closely, deeply punctured, and with abundant impressed points; vestiture largely confined to sides and asperate area.

Elytra 1.5 times as long as wide; sides straight and parallel on basal two-thirds, semicircularly rounded behind; striae and interstriae indistinguishable, the punctures fine, shallow, confused. De-

clivity convex, rather steep, interspace 2 rather strongly impressed. Vestiture abundant, consisting of short semierect bristles, narrow anteriorly, almost scalelike posteriorly, and rows of longer erect scales on declivital interspaces 1, 3 and 4, each scale shorter than twice the length of the ground vestiture and only slightly wider.

Female.—Similar to male except frons more coarsely punctured, with the vestiture shorter, less abundant and more uniformly distributed.

Type Locality.—Zamorano, Morazan, Honduras.

Hosts.—*Quercus sapotaefolia* (type), and *hondurensis* (paratype).

Type Material.—The male holotype, female allotype and 39 paratypes from branches of *Quercus sapotaefolia* and 9 paratypes from *Q. hondurensis* were taken at the type locality on April 19, 1964, at an elevation of 2,200 feet, by S. L. Wood. Five other paratypes were collected at Volcan de Agua, Guatemala, on May 19, 1964, from *Quercus* branches, at an elevation of 3,000 feet by S. L. Wood. Six additional paratypes were taken 7 miles northeast of Copala, Sinaloa, Mexico, on July 22, 1953, at an elevation of 3,000 feet, by S. L. Wood.

The holotype, allotype and paratypes are in my collection.

Pseudopityophthorus micans, n. sp.

This species evidently is allied to *opacicollis* Blackman, but it is unique in having the pronotum and elytra glabrous, smooth and shining.

Male.—Length 2.2 mm. (paratypes 2.0-2.5 mm.), 2.7 times as long as wide; color dark brown.

Frons plano-convex on three-fourths of a circle, smooth and shining at center with a marginal fringe of closely placed, long, erect, hairlike setae, marginal pubescent area closely, finely granulate-punctate. Eye deeply emarginate; finely granulate. Antennal club widest through segment 3.

Pronotum 1.1 times as long as wide; sides weakly arcuate, almost parallel on basal half, then moderately constricted before the rather narrowly rounded anterior margin; anterior margin armed by about 14 small teeth; summit indefinite; posterior area behind summit smooth and shining with rather abundant fine punctures and minute points; glabrous except at margins.

Elytra 1.6 times as long as wide; sides straight and subparallel on basal two-thirds, abruptly narrowed at posterolateral angles, rather narrowly rounded behind; elytral punctures largely limited to anterior two-thirds of disc, fine, confused except for striae 1; surface smooth and shining but marked with a few fine lines. Declivity abrupt with apical and sutural area somewhat produced posteriorly; surface smooth and shining. Glabrous except for a few setae at anterolateral angles.

FEMALE.—Similar to male except frons finely, deeply punctured except for a narrow median line; frontal vestiture sparse, scattered; and declivital punctures minute but evident.

Several paratypes are more distinctly punctured on the elytral declivity than the type. Some also appear dull, rather than shining; the shine evidently disappears with advancing age.

TYPE LOCALITY.—Sixty miles west of Durango, Durango, Mexico.

HOST.—*Quercus* spp.

TYPE MATERIAL.—The male holotype, female allotype and 23 paratypes were taken at the type locality on June 5, 1965, at an elevation of 7,000 feet, from a dying oak tree about 10 inches in diameter, by S. L. Wood. Other paratypes were collected in Mexico as follows: seven from 20 miles west of Durango, Durango; four from 18 miles west and one from three miles west of El Salto, Durango; four from 33 miles east of Moralia, Michoacan; and three from four miles south of Carapan, Michoacan; all were taken from oak trees, between 7,000 and 9,000 feet in elevation during June 1965, by S. L. Wood. Thirteen additional paratypes were taken 10 miles west of El Salto, Durango, in July 1964, by J. B. Thomas.

The holotype, allotype and most of the paratypes are in my collection; other paratypes are in the Canadian National Collection.

Gnathotrichus dentatus, n. sp.

Fig. 1

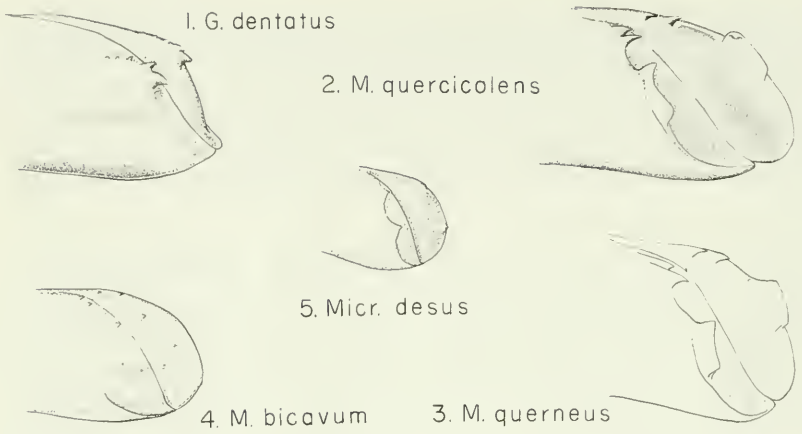
This unique species differs from all previously described species in having the elytral declivity of the male rather deeply sulcate and armed by a pair of large bi- or tridentate processes. The pubescence of pronotum and declivity is also much more conspicuous than in previously known species.

MALE.—Length 3.4 mm. (paratypes 3.1-3.6 mm.), 3.1 times as long as wide; color dark brown.

Frons very broad, convex; surface rather coarsely, shallowly punctured becoming increasingly aciculate toward median portion of epistoma; a short, transverse, elevated carina in median area at upper level of eyes and from it an impunctate line extending dorsad; vestiture short, inconspicuous.

Pronotum 1.2 times as long as wide; sides straight and parallel on basal half, rather broadly rounded in front; anterior margin armed by 10 low serrations; summit indefinite, in front of middle; posterior area smooth, subshining, finely, shallowly, rather sparsely punctured; vestiture fine, short, rather abundant on sides.

Elytra 2.0 times as long as wide; sides almost straight and parallel on basal three-fourths, narrowly rounded behind and narrowly notched at suture; punctures obsolete, striae and interstriae not indicated; surface very finely marked by surface lines and indefinite, shallow punctures, dull. Declivity with a broad, moderately deep



Figs. 1-5. Posterolateral aspect of male elytral declivity; 1, *Gnathotrichus dentatus;* 2, *Monarthrum quercicolens;* 3, *M. querneus;* 4, *M. bicavum;* and 5, *Microcorthylus desus.*

sulcus between the pair of prominent processes borne on interspace 3; lateral processes supported on prominent lateral elevations, the processes arising from median edge of elevation and bearing on dorsal margin a series of (two or) three rather large teeth; the teeth directed caudad and somewhat mesad, increasing slightly in size posteriorly; about three small dentitions on third interspace anterior to process, and with three similar small tubercles on interspace 1 at base of declivity; elytral apex explanate and narrowly notched. Vestiture consisting of rather abundant minute hairs and some longer, erect, coarse, hairlike setae.

Female.—Similar to male except frons less strongly convex and devoid of carina; anterolateral angles of pronotum with a small tuft of hair; and elytral declivity with sulcus shallow, lateral processes not strongly developed, and dentitions absent except for one or two small, rounded granules.

Type Locality.—Eighteen miles west of El Salto, Durango, Mexico.

Host.—*Quercus* sp.

Type Material.—The male holotype, female allotype and 20 paratypes were taken at the type locality on June 7, 1965, from the bole of a very large oak, at an elevation of 7,500 feet, by S. L. Wood. Other paratypes include: 11 same data as holotype but taken three miles west of El Salto; four taken 10 miles west of El Salto during July 1964, by J. B. Thomas; one taken 16 miles east and 21 taken 33 miles east of Moralia, Michoacan, Mexico, on June 14, 1965, from a *Quercus* bole, at an elevation of 9,000 feet by S. L. Wood.

The holotype, allotype and some paratypes are in my collection, other paratypes are in the Canadian National Collection.

Gnathotrichus nimifrons, n. sp.

This species is allied to *dentatus* Wood, described above, but is readily distinguished by its smaller size, by the narrower and longer declivital sulcus with the lateral processes undeveloped.

Male.—Length 3.0 mm. (allotype 2.7 mm.), 3.3 times as long as wide; color brown.

Frons very broad, strongly convex; surface smooth and shining in central area, shallowly punctured laterally, weakly aciculate toward epistoma; vestiture sparse, inconspicuous.

Pronotum 1.3 times as long as wide; as *dentatus* except posterior areas more finely, shallowly and closely punctured.

Elytra 1.9 times as long as wide; sides straight and subparallel on basal three-fourths, rather narrowly rounded behind, shallowly notched at suture; striae and interspaces not indicated; surface minutely irregular, with rather sparse, shallow, fine punctures. Declivity rather narrowly, deeply sulcate, moderately steep; suture not raised, lateral area including interspace 3 strongly elevated from declivital base about two-thirds the distance to apex, the crest armed by about seven small, pointed granules; elytral apex explanate, narrowly notched. Vestiture consisting of fine, short hairlike setae on disc and sides, becoming much longer and abundant on declivity.

Female.—Similar to male except frons less strongly convex and with fine aciculate lines extending at least to upper level of eyes; and declivity shallowly sulcate, the lateral elevations poorly developed, the granules fewer in number and smaller.

Type Locality.—Eighteen miles west of El Salto, Durango, Mexico.

Host.—*Quercus* sp.

Type Material.—The male holotype, female allotype and one male paratype were collected at the type locality on June 7, 1965, at an elevation of 7,500 feet, by S. L. Wood, from the bole of the same large oak tree that contained the holotype of *dentatus*. One paratype is from Carr Canyon, Arizona, taken at blacklight, on August 8, 1962, by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Gnathotrichus perniciosus, n. sp.

This species is allied to, but not closely related to *deleoni* Blackman. It is distinguished by the smaller size, by the more slender form, by the very different frons, by the striate elytral disc, by the sculpture of the elytral declivity, and by other characters.

Male.—Length 2.4 mm. (paratypes 2.2-2.6 mm.), 3.2 times as long as wide; color dark brown, the elytral bases somewhat lighter.

Frons moderately convex; surface convergently aciculate from upper level of eyes to median point on epistoma, two of the ridges on median line (one in some paratypes) more strongly raised, par-

ticularly above, the grooves between ridges and above aciculate area rather sparsely, deeply, coarsely punctured.

Pronotum 1.2 times as long as wide; widest at base, the sides straight, converging anteriorly very slightly on basal three-fourths, then broadly rounded in front; anterior margin armed by about 12 low, blunt teeth; summit well in front of middle, marked by a raised transverse line; posterior area finely reticulate, dull, very finely, rather sparsely punctured; vestitute inconspicuous, confined to sides.

Elytra 1.8 times as long as wide; sides almost straight and parallel on basal three-fourths, narrowly rounded behind, with a very small notch at suture; striae not impressed, the punctures in semidefinite rows, small, shallow; interspaces with surface lines, points, and an occasional puncture, subshining. Declivity steep, narrowly and shallowly sulcate; striae 1 and 2 indicated by fine, shallow punctures; interspaces 1 and 2 very narrow, impressed, 3 moderately, rather abruptly elevated and armed by about four rounded granules. Vestiture limited to declivity, fine, hairlike, short and a few longer setae intermixed.

Female.—Similar to male except outer margin of antennal funicle and club bearing a few long setae.

Type Locality.—Six miles south of Carapan, Michoacan, Mexico.

Hosts.—*Pinus* spp.

Type Material.—The male holotype, female allotype and 69 paratypes were collected at the type locality on June 18, 1965, at an elevation of 7,000 feet, from the base of a pine 12 inches in diameter, by S. L. Wood. Other paratypes, all taken in Mexico, include: two from Tres Rios, Chihuahua, July 13, 1959, by W. W. Tanner and G. W. Robison; one from 20 miles northeast of Copala, Sinaloa, July 22, 1953, from *Pinus*, by S. L. Wood; three from the southeast slopes of Mt. Colima, Colima, Dec. 2, 1948, by E. S. Ross; two from near Cuernavaca, Morelos, August 5, 1949, by J. P. Perry; one from seven miles south of Mazamitla, Jalisco, December 1, 1948, by H. B. Leech; and one from 15 miles south of El Guarda, Distrito Federal, November 14, 1946, by E. S. Ross. This species was also taken at Cerro Pena Blanca, San Lucas, Yuscaran, and Zamorano, Honduras, from *Pinus oocarpa* and *pseudostrobus*, but the specimens from these localities are not designated paratypes.

The holotype, allotype and some of the paratypes are in my collection, other paratypes are in the California Academy of Sciences.

Gnathotrichus imitans, n. sp.

This species evidently is more closely allied to *perniciosus* Wood, described above, than to other known forms, but it is easily distinguished by the black or dark brown color, by the impressed lower half of the frons, and by the more strongly striate elytra.

Adult.—Length 3.0 mm. (paratypes 2.9-3.1 mm.), 3.3 times as long as wide; color dark brown.

Frons impressed on more than median half from upper level of eyes to epistoma, convergently aciculate toward median point on epistomal margin on most of impressed area; surface coarsely, rather sparsely, deeply punctured over most of front of head to vertex; a median carina extending dorsad from upper level of eyes; vestiture sparse, inconspicuous.

Pronotum 1.4 times as long as wide; widest at base, sides almost straight on basal three-fourths and slightly converging anteriorly, rather broadly rounded in front; anterior margin with an irregular, indistinctly serrate, raised rim; summit well in front of middle, clearly marked by a transverse elevation; posterior area almost smooth and shining, rather closely, deeply, finely punctured; vestiture restricted to sides.

Elytra 1.9 times as long as wide; sides straight and subparallel on basal three-fourths, rather narrowly rounded behind; striae not impressed, the punctures small, deep; interstriae little wider than striae, marked by a few surface lines and points, subshining. Declivity moderately steep, convex; all punctures minute, not clearly impressed; interspace 1 weakly elevated, 2 impressed, 3 slightly elevated and armed by a series of about five very small granules; apical margin not extended as in most representatives of the genus. Vestiture confined to sides and declivity; longer and in distinct rows on declivital interspaces 3 and 4.

Sexual differences are not apparent in the material at hand, although both sexes probably are represented.

Type Locality.—Three miles west of El Salto, Durango, Mexico.

Type Material.—The holotype (a female?) and six paratypes were collected at the type locality on June 7, 1965, at an elevation of about 7,500 feet, in flight, by S. L. Wood. Other paratypes were collected in flight near the type locality as follows: 4 from El Salto, June 3, 1937, by Juan Manual, and 69 from 10 miles west of El Salto, during July 1964, by J. B. Thomas.

The type and some of the paratypes are in my collection, other paratypes are in the California Academy of Sciences and the Canadian National Collection.

Monarthrum quercicolens, n. sp.

Fig. 2

Of the described species known to me this species evidently is more closely allied to *scutellare* (Leconte), but it is not closely related. The third pair of elevated processes on the declivity and the pubescent female frons serve to distinguish it from other species.

Male.—Length 4.0 mm. (paratypes 3.7-4.3 mm.), 3.1 times as long as wide; pronotum brown, elytral base light brown, posterior half of elytra dark brown.

Frons convex, with a feeble median elevation below; surface reticulate below, subshining above, finely, deeply, rather closely

punctured; glabrous. Antennal club 1.8 times as long as wide, widest one-third from apex.

Pronotum 1.4 times as long as wide; sides almost straight and parallel on basal two-thirds, broadly rounded in front; anterior margin not clearly armed although several irregular, submarginal asperities present; asperities restricted to slightly more than anterior third; posterior area subreticulate, dull, with sparse, minute, shallow punctures; glabrous.

Elytra 1.9 times as long as wide; sides straight and subparallel on basal three-fourths, abruptly rounded behind, shallowly emarginate toward suture; elytral punctures very fine, more or less in rows, those of striae and interstriae similar in size and depth; surface marked by irregular surface lines and points, subshining. Declivity broadly, concavely excavated, abrupt, moderately steep; interspaces 2 and 3 each armed at base by a rather large, sharply pointed tooth; lateral margin raised, abruptly rounded from second tooth to apex with its middle third abruptly produced forming a long, flattened process on lateral margin about equal in height to teeth on upper margin; sutural margin feebly elevated, the concavity broadly concave, its surface rather coarsely, deeply punctured. Elytra glabrous, except in declivital excavation rather densely pilose, the setae fine, rather long, with marginal row of setae distinctly longer.

Female.—Similar to male except frons less strongly convex, with a small, shallow, median impression and subtriangular patch of rather dense, fine, erect hair on median third between upper level of eyes and epistoma; declivity not excavated, with two pair of small tubercles on interspace 2; and antenna with tuft of hair characteristic of genus.

Type Locality.—Thirty-three miles east of Moralia, Michoacan, Mexico.

Host.—*Quercus* sp.

Type Material.—The male holotype, female allotype and three paratypes were taken at the type locality on June 14, 1965, from a large oak log, at an elevation of 9,000 feet, by S. L. Wood. Other paratypes were taken in Mexico from oak as follows: five from Carapan, Michoacan, June 18, 1965, 7,000 feet elevation; one from three miles west of El Salto, Durango, June 7, 1965, 7,500 feet elevation, all by S. L. Wood; six from 10 miles west of El Salto, during July 1964, by J. B. Thomas.

The holotype, allotype and some of the paratypes are in my collection, other paratypes are in the Canadian National Collection.

Monarthrum querneus, n. sp.

Fig. 3

This species is related to *quercicolens* Wood, described above, but is readily distinguished in the male by the smaller size, by the shallower, more widely flattened elytral declivity, and by the slightly

longer third pair of declivital processes; the female frons is glabrous and has a moderately large cavity on the vertex.

MALE.—Length 3.1 mm. (paratypes 2.8-3.4 mm.), 3.3 times as long as wide; color dark brown with sides and base of pronotum and basal two-thirds of elytra lighter.

Frons convex, with a low median elevation below; surface coarsely reticulate below, becoming smooth above with rather close, shallow punctures and numerous fine points; glabrous.

Pronotum and elytral disc as *quericicolens*. Declivity about as in *quercicolens* but concavity more broadly flattened, the apical margin less strongly produced, and the flattened lateral processes a little shorter and higher with the declivital vestiture less well developed.

FEMALE.—Similar to female of *quercicolens* except frons convex and glabrous with moderately large impression on vertex as wide as antennal club and shorter than wide, the impression abrupt above, gradual below, its depth equal to less than one-fourth its width.

TYPE LOCALITY.—Thirty-three miles east of Moralia, Michoacan, Mexico.

HOST.—*Quercus* sp.

TYPE MATERIAL.—The male holotype, female allotype and 42 paratypes were taken at the type locality on June 14, 1965, at an elevation of 9,000 feet, by S. L. Wood, from the same large oak log that contained the holotype of *quercicolens*.

The holotype, allotype and paratypes are in my collection.

Monarthrum bicavum, n. sp.

Fig. 4

While the declivital structure of this species has a superficial resemblance to that of *vittatum* Blandford, the two are not closely related. In this species the apical margin of the declivity forms a finely raised, continuous line across the entire posterior margin of the declivity without a sutural emargination. The female frons is also unique in being shallowly concave from eye to eye and from vertex to epistoma with a low median elevation dividing it.

FEMALE.—Length 2.9 mm. (paratypes 2.9-3.3 mm.), 3.0 times as long as wide; color dark brown.

Frons shallowly concave from eye to eye and from vertex to epistoma, its margin abruptly rounded; concavity divided by a median carina, subacute above, broad below; each half of concavity with an almost hemispherical impression at upper level of eyes about equal in diameter to greatest width of eye; entire surface of concavity and carina densely covered by very short pilose hair. Antennal club 1.4 times as long as wide, widest one-third from distal end, marked by two strongly arcuate sutures; posterior face bearing tuft of hairlike setae as in other species of the genus.

Pronotum 1.2 times as long as wide, subquadrate, the sides weakly arcuate, anterior margin only slightly more strongly arcuate, the anterior angles only slightly more broadly rounded than those of base; summit two-fifths of pronotum length from anterior margin, poorly developed; posterior area minutely reticulose-granulose, impunctate; glabrous.

Elytra 1.5 times as long as wide; sides almost straight and parallel on basal two-thirds, then slightly convergent posteriorly to declivital base, then rather abruptly angled and broadly rounded behind; strial and interstrial punctures not in definite rows, but not entirely confused, the punctures small, not deep; surface shallowly reticulate and with surface lines, subshining. Declivity rather abrupt, very steep, sulcate on upper half; punctures not clearly evident but sutural interspace feebly raised, 2 narrow, impressed about to middle of declivity, 3 rather strongly raised above but disappearing by middle of declivity and armed by a small tubercle near upper limit and another at middle of declivity, the lower tubercles more widely separated from one another than the upper; the lower third of lateral margin marked by an acute, low, elevated line continuing without interruption to apex, not emarginate at suture; surface minutely reticulose-granulose. Vestiture scanty, restricted to sides and declivity.

Male.—Similar to female except frons weakly convex, with a broad irregular median carina, the surface granulose with sparse, shallow punctures; posterior area of pronotum with shallow punctures indicated; and declivity more broadly flattened above, the elevation of interspace 3 forming an indefinite crescent on middle third of declivity, and three or four fine tubercles may occur.

Type Locality.—Laguna Santa Maria, Nayarit, Mexico.

Host.—*Quercus* sp.

Type Material.—The female holotype, male allotype and 19 paratypes were collected at the type locality on July 16, 1965, from the bole of a fallen oak, at an elevation of 3,000 feet, by S. L. Wood.

The holotype, allotype and paratypes are in my collection.

Microcorthylus desus, n. sp.

Fig. 5

Of the described species known to me none are closely related and, at best, only superficially resemble this species. Superficially it might be placed intermediate between *Monarthrum egenum* Blandford and *M. edentatum* Eggers. The subvertical declivity and nonemarginate elevated apex of the elytra distinguish this species. In some respects it might resemble *M. bicavum* Wood, described above.

Male.—Length 1.9 mm. (paratypes 1.8-2.1 mm.), 2.5 times as long as wide; color brown.

Frons convex, coarsely, not closely or deeply punctured, with a small, elongate median tubercle at upper level of eyes; vestiture inconspicuous. Antennal club oval, 1.5 times as long as wide, widest at middle, two sutures very weakly angulate; funicle one-segmented.

Pronotum 1.3 times as long as wide; sides straight and subparallel on basal half, rather broadly rounded in front; anterior margin unarmed; summit at middle; posterior area reticulate, dull, very finely, sparsely punctured; disc glabrous.

Elytra about 1.5 times as long as wide; sides straight and parallel to declivital base, posterior margin straight, the posterior angles curving caudomesad to form lower declivital spines with their apices directed mesad; elytral punctures small, indistinct, confused, the surface reticulate, dull. Declivity abrupt, subvertical, somewhat more gradually rounded at base near suture; face broadly, rather shallowly concave, the lateral margin rather strongly, broadly elevated and armed by a rather large, pointed tubercle on upper third about in line with normal position of striae 3 and a larger incurved, hooked spine two-thirds of declivital length from top; height of lower spine about equal to its basal width, its apex directed mesad; apical margin acutely, not strongly elevated on median half of elytral width, not at all emarginate at suture. Vestiture not conspicuous, limited to sides and declivity.

Female.—Similar to male except elytral declivity less strongly sculptured, only moderately impressed, the lateral areas not high, the tubercles small; apical margin of elytra, frons and antenna as in male.

Type Locality.—Sixteen miles east of Moralia, Michoacan, Mexico.

Host.—*Quercus* sp.

Type Material.—The male holotype, female allotype, and 18 paratypes were collected at the type locality on June 14, 1965, at an elevation of 7,600 feet, by S. L. Wood, from the dying limb of an oak.

The holotype, allotype and paratypes are in my collection.

Amphicranus quercus, n. sp.

Figs. 6-7

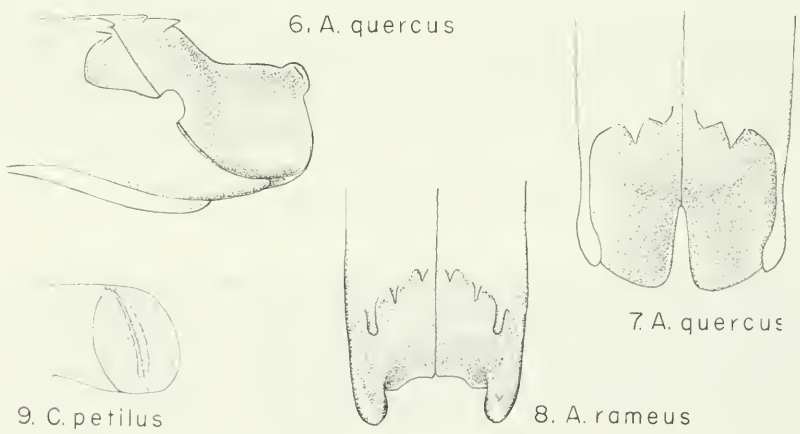
This species is allied to *torneutes* Blandford, but it is much smaller, it lacks a frontal callosity, and it has only one rounded and one pointed tooth near suture at base of male declivity.

Male.—Length 4.5 mm. (paratype males 4.4-4.6, females 3.4-3.8 mm.), 3.4 times as long as wide; color dark brown.

Frons convex, the surface rather coarsely, shallowly punctured except small area at center; epistoma bearing a sparse, poorly developed brush of hair directed orad. Antennal funicle two-segmented; club with sutures 1 and 2 evenly, rather weakly arcuate.

Pronotum 1.8 times as long as wide; sides straight and parallel on basal two-thirds, then anteriorly narrowed slightly to an abrupt subangulate point and broadly rounded in front; anterior area rather abruptly declivous, the indefinite summit one-third from anterior margin; asperities fine, confused except a small area equal in size to antennal club medially from summit forward, slightly impressed and devoid of asperities, its surface reticulate; posterior area indistinctly reticulate, dull with fine, sparse punctures; glabrous.

Elytra 2.1 times as long as wide; sides straight and almost parallel from base to level even with apex of third declivital teeth, very slightly wider just before apex of elytra, broadly rounded behind and very deeply, broadly emarginate; depth of cleft equal to one-fifth elytral length, its width equal to one-half its depth; striae very indistinctly indicated by minute, shallow punctures, interstriae with a few confused similar punctures, surface essentially smooth, dull. Declivity abrupt, sharply margined above, excavated, with lateral areas very strongly produced, floor of cavity broadly flattened, rather steep; upper third sharply margined by a low elevation about as high as thick, its sutural half bearing two almost equal dentitions, one at interspace 2, pointed, the other bluntly rounded at sutural interspace; lower two-thirds of lateral margin abruptly, very strongly produced posteriorly, upper margin of this process horizontal to level equal with sutural apex, then armed by a large, short, flat, blunt posterodorsally projecting process, and continuing posteroventrally to acute, very deep sutural emargination. Vestiture confined to declivity, consisting of rather abundant short, fine, erect hair in the excavated area, with much longer setae on margins of expanded lateral areas.



Figs. 6-9. Male elytral declivity of: 6-7, *Amphicranus quercus*, posterolateral and dorsal aspects; 8, *A. rameus*, dorsal aspect; and 9, *Corthylus petilus*, posterolateral aspect.

FEMALE.—Similar to male except inner face of antennal club bearing a tuft of hair, impressed reticulate area in front of pronotal summit absent, and declivity simple, flattened, with a low, acute margin on lower half only and armed by two pair of moderately small, pointed tubercles on interspace 3, one near upper margin, the other near middle of declivity; declivity subglabrous.

TYPE LOCALITY.—Three miles west of El Salto, Durango, Mexico.

HOST.—*Quercus* sp.

TYPE MATERIAL.—The male holotype, female allotype and 44 paratypes were collected at the type locality on June 27, 1965, at an elevation of 7,500 feet, by S. L. Wood, from the boles of several large oak trees.

The holotype, allotype and paratypes are in my collection.

Amphicranus rameus, n. sp.

Fig. 8

This species is similar to *propugnatus* Blandford, but it may be distinguished by the presence of a specialized, raised, coarsely reticulate, frontal area, and by very different arrangement of the elytral declivity.

FEMALE.—Length 3.7 mm. (paratypes 3.5-3.7 mm.), 3.7 times as long as wide; color of pronotum in front of summit, elytral declivity and abdomen almost black, remainder of pronotum reddish brown, remainder of elytra yellowish brown.

Frons convex, its surface reticulate and rather coarsely, indistinctly punctured, median third with a low, sharply raised, flat, coarsely reticulate area having outline of a cup (more nearly heart-shaped in paratypes); vestiture inconspicuous. Antennal funicle two-segmented; club with two non-septate weakly arcuate sutures.

Pronotum 1.5 times as long as wide; sides straight and parallel on basal three-fifths, rather narrowly rounded in front; anterior margin projecting downward very slightly at center, armed by about 10 low teeth, the median pair more prominently extended; summit three-fifths of pronotum length from base, indefinite; rather strongly declivous and coarsely asperate in front of summit, posterior area finely reticulate with small, shallow, rather sparse punctures; glabrous.

Elytra 2.2 times as long as wide; sides straight and parallel to a point even with sutural apex, posterolateral angles convergently projecting behind beyond the broadly emarginate elytral apex; disc irregularly smooth, shining, subsurface punctures suggested but not attaining surface. Declivity abrupt, moderately steep, broadly excavated; margin subacutely elevated from interspace 1 about two-thirds of distance from top of declivity, the elevation not as high as wide, then continued on lower third to projecting subquadrate, converging lateral processes, the processes about one and one-half

times as long as their width in lateral profile; lateral margin armed by small, equal, pointed spines on interspaces 1 and 3 at base of declivity, and at interspace 4 by a slender blunt tooth about twice as long as upper ones; lateral processes without special armature; median two-thirds of posterior margin emarginate, the emargination about half as deep as wide. Vestiture fine, scanty, confined to declivity.

Male.—Similar to female except frontal raised callus absent; a smaller tuft of hair present on antennal club.

Type Locality.—Three miles west of El Salto, Durango, Mexico.

Host.—*Quercus* sp.

Type Material.—The female holotype, male allotype and two female paratypes were collected at the type locality on June 7, 1965, at an elevation of 7,500 feet, by S. L. Wood, from a limb four inches in diameter of the same large oak species that produced *quercus* Wood (above).

The holotype, allotype and paratypes are in my collection.

Corthylus petilus, n. sp.

Fig. 9

Although this species is truncate behind as in *compressicornis* (Fabricius), it is not at all closely related. It differs from *compressicornis* by the smaller, more slender body, and in the female, by the absence of a tuft of hair on the antennal club and the presence of a pale, spongy area on the epistomal area.

Female.—Length 2.0 mm. (paratypes 1.9-2.1 mm.), 2.5 times as long as wide; color dark brown.

Frons rather deeply concave from eye to eye and from epistoma to vertex; upper three-fourths rather coarsely reticulate, finely, shallowly punctured, shining; lower fourth spongy, dull, pale in color; margin above eyes ornamented by a fringe of rather long, plumose hair. Antennal club much as in *compressicornis*, without a tuft of hair.

Pronotum about equal in length and width; widest on basal third, sides weakly arcuate, very boardly rounded in front; summit well in front of middle, rather steeply declivous in front; posterior area reticulate, becoming almost smooth and shining at base, finely, sparsely punctured; glabrous.

Elytra 1.7 times as long as wide; sides almost straight and parallel to truncate declivity, very weakly rounded behind; strial and interstrial punctures small, distinctly impressed, confused except striae 1 and 3 almost discernible toward declivity; surface with a few obscure lines and points, shining. Declivity subvertical, truncate, the margin abruptly rounded on upper half, acute below; rather strongly impressed on a complete circle, particularly below; sutural interspace strongly elevated on middle two-thirds, gradually reduced

above, more abruptly reduced below and obsolete before apex; surface smooth and shining except coarsely reticulate on sutural interspace, the punctures coarse, deep; sutural interspace armed by a row of about nine rounded granules. Almost glabrous.

Male.—Similar to female except frons convex, reticulate, with a few deep, coarse punctures; anterior margin of pronotum more strongly rounded and armed by two closely set, moderately large teeth.

Type Locality.—Three miles west of El Salto, Durango, Mexico.

Host.—*Quercus* sp.

Type Material.—The female holotype, male allotype and three paratypes were collected at the type locality on June 7, 1965, at an elevation of 7,500 feet, by S. L. Wood, from the same oak branch that contained the type series of *Amphicranus rameus* Wood (above).

The holotype, allotype and paratypes are in my collection.

The Great Basin Naturalist

Founded in 1939 by Vasco M. Tanner

A journal published from one to four times a year by Brigham Young University, Provo, Utah.

MANUSCRIPTS: Only original, unpublished manuscripts, pertaining to the Great Basin and the western United States in the main, will be accepted. Manuscripts are subject to the approval of the editor.

ILLUSTRATIONS: All illustrations should be made with a view to having them appear within the limits of the printed page. The illustrations that form a part of an article should accompany the manuscript. All half-tones or zinc etchings to appear in this journal are to be made under the supervision of the editor, and the cost of the cuts is to be borne by the contributor.

REPRINTS: No reprints are furnished free of charge. A price list for reprints and an order form is sent with the proof.

SUBSCRIPTION: The annual subscription is $2.50 (outside the United States $3.25). Single number, 80 cents.

All correspondence dealing with manuscripts should be addressed to the Editor, Vasco M. Tanner, Great Basin Naturalist, Brigham Young University, Provo, Utah. Other matters such as subscriptions, reprints, exchanges and other business should be addressed to Ernest L. Olson, Chairman of University Publications.

REPRINTS SCHEDULE OF THE GREAT BASIN NATURALIST

	2 pp.	4 pp.	6 pp.	8 pp.	10 pp.	12 pp.	Each Additional 2 pp.
50 copies	$6.00	$7.00	$8.00	$9.00	$10.00	$11.00	$2.00
100 copies	7.00	8.00	9.00	10.00	11.00	12.00	
200 copies	8.00	9.00	10.00	11.00	12.00	13.00	
300 copies	9.00	10.00	11.00	12.00	13.00	14.00	

COVERS: $10.00 for first 100 copies, $4.00 for additional 100 copies.

TABLE OF CONTENTS

On Two Little-Known Species of the Earthworm Genus *Diplocardia*. G. E. Gates 1

Spiders of the Nevada Test Site. Illustrated. Dorald M. Allred and D Elden Beck 11

Problems of Sampling Desert Arthropods Before and After a Thermonuclear Cratering Test. Illustrated. Clayton S. Gist 26

New Species of Bark Beetles (Coleoptera: Scolytidae), Mostly Mexican. Part VII. Illustrated. Stephen L. Wood 36

Volume XXVII, No. 2
September 5, 1967

The Great Basin NATURALIST

Published by
Brigham Young University

The Great Basin Naturalist

Published at Provo, Utah by
Brigham Young University

Volume XXVII | September 5, 1967 | No. 2

A COMPARATIVE STUDY OF THE MOUNTAIN BRUSH VEGETATION IN UTAH[1]

Elray S. Nixon[2]

Abstract: A comparative study was made of an exclosure in the mountain brush vegetation of the Wasatch Mountains, Utah. The exclosure is located in Pole Canyon, near Provo, Utah, and was initially analyzed in 1948 and 1949 by Allman (1952, 1953). The dominant woody species of the vegetation in the exclosure were bigtoothed maple (*Acer grandidentatum*) and Gambel oak (*Quercus gambelii*). Results indicated that the maple had increased in relative cover whereas the oak decreased Serviceberry (*Amelanchier alnifolia*) had increased in both relative cover and frequency. Frequency data of forbs and grasses showed a general increase in early flowering annuals and perennials. Starflower (*Tellima parviflora*) and wyethia (*Wyethia amplexicaulis*) were two of the more prominent species which were new in the exclosure. The complete disappearance of western wheat grass (*Agropyron smithii*) from 67 percent frequency and the increase of Kentucky bluegrass (*Poa pratensis*) represented the greatest changes of grasses in the exclosure. Precipitation was recorded from May 1, 1958, to April 30, 1959. Soil data obtained included pH, soluble salt content, cation exchange capacities, mechanical analyses, and content of available calcium, magnesium, and potassium. Soils were analyzed at six-inch intervals to a depth of 24 inches.

Introduction

Allman (1952, 1953) presented a history of the study area and indicated that during the years that followed the first settlements in and around Provo, Utah, the area became heavily overgrazed by livestock. It was not until the late 1930's that the study site was included within the boundaries and management of the Uinta National Forest. As a result, grazing by livestock was restricted until 1949, when the study area was fenced and analyzed by Allman

1. Appreciation is extended to Dr. Earl M. Christensen (Brigham Young University, Provo, Utah) for suggestions and guidance, the late Dr. Merrill J. Hallam for aid in soil analyses, and to Mark Garrett for assistance with the field work.

2. Stephen F. Austin State College, Nacogdoches, Texas.

1952, 1953). The present study was proposed to determine any changes occurring within the exclosure since the initial study and to obtain certain environmental data which might supplement these results.

The exclosure is located in Pole Canyon, which is situated in the mountain brush vegetation to the northeast of Provo, Utah. It is specifically located in Section 9 of Township 6 South, Range 3 East, and is at an elevation of approximately 6,500 feet. The dominant woody species of the area are big-toothed maple (*Acer grandidentatum*) and Gambel oak (*Quercus gambelii*). Of less prominence are such species as serviceberry (*Amelanchier alnifolia*), ninebark (*Physocarpus malvaceus*), and snowberry (*Symphoricarpos vaccinioides*). The study was begun during the spring of 1958, and it continued through the summer of 1959.

Methods and Procedures

The exclosure consisted of 132 five-meter-square contiguous quadrats arranged on a grid. These quadrats were permanently marked and used to acquire frequency data for all species. Cover and relative cover data of the woody vegetation were obtained by the line-intercept method using a steel tape stretched along the grid lines separating the quadrats.

Three sites were chosen just outside the exclosure for collecting soil samples. At each site there were three collection points, one beneath an oak canopy, one beneath a maple canopy, and one beneath a herbaceous cover. Samples were taken at depths of 6, 12, 18, and 24 inches. Analyses of duplicate samples included pH, a mechanical analysis by the Bouyoucos hydrometer method, soluble salt content with the use of a salt bridge, cation exchange capacity by the ammonium acetate extraction method, and the amount of available calcium, magnesium, and potassium present by use of a Beckman flame-spectrophotometer. The moisture equivalents were determined by the centrifuge method. The wilting point of the soil was found by growing sunflower and wheat plants in glass tumblers in a greenhouse.

A rain gauge was placed inside the exclosure and precipitation measurements were taken from May 1, 1958, until April 39, 1959. These measurements were made the day after the storm unless the study area was inaccessible due to muddy roads. During the winter months of January, February, and March the area was entered on snowshoes; consequently, measurements were taken at the end of each month.

Results

Vegetation

Results concerning the woody vegetational cover of the exclosure indicated that the area could be divided into two vegetational types. The west part was located on a ridge and contained high proportions of both oak and maple (Table 1). The east part was located on a

Table 1. A comparison of the canopy cover of the east and west parts of the exclosure in 1949 and 1958

Species	West part (ridge)				East part (slope)			
	% Relative cover		% Cover		% Relative cover		% Cover	
	1949	1958	1949	1958	1949	1958	1949	1958
Maple	40.7	50.9	33.8	44.6	74.6	71.6	60.6	58.9
Oak	55.9	43.8	46.4	38.4	22.1	21.8	17.9	17.9
Serviceberry	1.0	2.9	0.8	2.5	2.0	3.4	1.6	2.8
Ninebark	0.0	0.4	0.0	0.4	0.0	0.9	0.0	0.7
Snowberry	0.0	0.5	0.0	0.4	0.0	0.4	0.0	0.3
Rose	0.0	0.2	0.0	0.2	0.0	Trace	0.0	Trace
Douglas fir	2.4	1.3	2.0	1.1	0.0	0.0	0.0	0.0
White fir	0.0	0.0	0.0	0.0	1.2	1.8	1.0	1.5
Juniper	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
Total	100.0	100.0	83.0	87.6	100.0	99.9	81.2	82.1

east-facing slope and the canopy was predominantly maple. An analysis of the east part showed very little change during the nine-year period in regard to oak and maple cover (Table 1). The area upon the rise, however, revealed some significant changes. There was a definite increase of maple in the canopy and a decrease of oak. Along with this, the total vegetative cover increased by 4.6 percent. Young maple trees invaded and spread in the areas which were inhabited mainly by oak in 1949. The oak, on the other hand, did not invade the areas of older maple trees. There were few young oak plants under the older maple in the exclosure.

Although maple, oak, rose (*Rosa woodsii*), and snowberry increased somewhat in frequency, the only shrub showing any marked change was serviceberry which had increased 14 percent (Table 2). In addition, 50 seedlings of serviceberry were counted in 132 one-meter-square quadrats located at random in the five-meter-square quadrats. Although white fir (*Abies concolor*) showed no change in frequency, there were six seedlings noted within the exclosure.

In general, an increase in frequency occurred in the majority of forbs (Table 2). Spring beauty (*Claytonia lanceolata*), dog-tooth violet (*Erythronium grandiflorum*), blue-eyed Mary (*Collinsia parviflora*), waterleaf (*Hydrophyllum capitatum*), nemophila (*Nemophila breviflora*), and starflower (*Tellima parviflora*) increased throughout the exclosure. Plants which increased under the tall maples in the east part of the exclosure were Engelmann aster (*Aster engelmanni*), larkspur (*Delphinium nelsonii*), peavine (*Lathyrus spp.*), and violet (*Viola praemorsa*). Dandelion (*Taraxacum officinale*) and mullein (*Verbascum thapsus*) decreased in the east part. In the west part of the exclosure, which is more open, larkspur and wyethia (*Wyethia amplexicaulis*) increased, while arrowleaf balsamroot (*Balsamorhiza sagittata*) geranium (*Geranium fremontii*), goldenrod (*Solidago altissima*), and mullein decreased.

Species found in the exclosure in 1958 which were not recorded in the preliminary study were starflower, western valerian (*Valeriana occidentalis*), wyethia, western wallflower (*Erysimum asper-*

Table 2. Comparative frequency data of species

Species	% Frequency 1949	1958	Species	% Frequency 1949	1958
Abies concolor	11.4	11.4	*Nemophila breviflora*	62.1	84.8
Acer grandidentatum	98.5	100.0	*Osmorhiza divaricata*	84.8	93.2
Achillea lanulosa	34.8	31.1	*Osmorhiza occidentalis*	1.5	1.5
Agastache urticifolia	18.9	14.4	*Physocarpus malvaceus*	16.7	18.9
Agropyron smithii	67.4	0.0	*Poa curta*	15.2	12.1
Agropyron subsecundum	69.7	59.1	*Poa pratensis*	15.2	32.6
Amelanchier alnifolia	46.2	60.6	*Poa secunda*	1.5	9.1
Aster engelmanni	32.6	37.1	*Polemonium albiflorum*	1.5	0.0
Balsamorhiza sagittata	5.3	0.0	*Pseudotsuga taxifolia*	3.0	3.0
Bromus carinatus	59.1	45.5	*Quercus gambelii*	89.4	95.5
Calochortus nuttallii	0.8	0.0	*Rosa woodsii*	2.3	5.3
Carex spp.	90.9	91.7	*Rudbeckia occidentalis*	4.5	2.3
Cirsium undulatum	0.8	0.8	*Sambucus coerulea*	0.8	0.8
Claytonia lanceolata	0.8	80.3	*Scrophularia occidentalis*	6.1	8.3
Collinsia parviflora	32.6	71.9	*Smilacina spp.*	93.2	86.4
Delphinium nelsonii	3.0	14.4	*Solidago altissima*	6.8	0.0
Elymus glaucus	32.6	50.8	*Stellaria jamesiana*	89.4	95.5
Erigeron speciosus	25.8	18.2	*Stipa columbiana*	18.2	9.8
Erysimum asperum	0.0	0.8	*Stipa lettermani*	1.5	9.8
Erythronium grandiflorum	14.4	88.6	*Symphoricarpos vaccinioides*	6.1	9.9
Fragaria bracteata	11.4	14.4	*Taraxacum officinale*	34.9	25.8
Fritillaria atropurpurea	0.8	0.0	*Tellima parviflora*	0.0	39.4
Galium aparine	83.3	94.7	*Thalictrum fendleri*	0.8	1.5
Galium boreale	81.1	82.6	*Valeriana occidentalis*	0.0	2.3
Geranium fremontii	18.2	8.3	*Verbascum thapsus*	50.0	18.2
Helianthella uniflora	1.5	4.5	*Vicia trifida*	87.1	93.9
Hydrophyllum capitatum	22.7	90.2	*Viguiera multiflora*	31.1	28.8
Lathyrus spp.	78.8	99.3	*Viola adunca*	37.1	32.6
Mahonia repens	47.7	45.5	*Viola praemorsa*	14.4	23.5
Melica bulbosa	7.6	2.3	*Woodsia sp.*	0.8	0.8
Mertensia brevistyla	0.0	0.8	*Wyethia amplexicaulis*	0.0	5.3
Montia perfoliate	0.8	0.0			

um), and shortstyle bluebell (*Mertensia brevistyla*). Arrowleaf balsamroot, goldenrod, and white polemonium (*Polemonium albiflorum*) were forbs recorded in the initial study which were not found in the exclosure during 1958.

Of the grasses present, western wheatgrass (*Agropyron smithii*) underwent the greatest change. It decreased from 67.4 percent frequency to 0 percent. Other grasses which decreased were bearded wheatgrass (*Agropyron subsecundum*), columbia needlegrass (*Stipa columbiana*), and mountain brome (*Bromus carinatus*). Kentucky bluegrass (*Poa pratensis*), blue wild rye (*Elymus glaucus*), letterman needlegrass (*Stipa lettermani*), and Sandberg bluegrass (*Poa secunda*) increased.

Precipitation and Soil

Rain and snow measurements recorded within the study area showed a total of 16.18 inches of precipitation during the year with about four-fifths of it being recorded from November to May (Fig. 1). Only 3.09 inches of rain fell from May 14 to November 7 and this

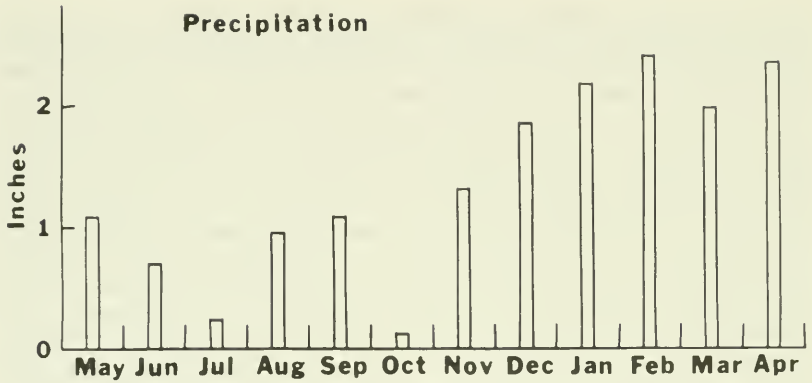


Fig. 1. Precipitation data obtained from within the exclosure.

was a result of 11 different storms. The highest amount of precipitation, 2.4 inches, was recorded in February. The snow depth at that time averaged about 30 inches. The smallest amount of precipitation fell in October when .12 of an inch was recorded. July was also very dry with only .23 of an inch of rainfall. Only one storm occurred in each of these months.

The parent material of the soil of the study site was composed of subordinate limestones and quartzites (Allman 1952). The A horizon was fairly well developed but varied in depth extending in places to more than 24 inches. On the ridge area in the exclosure it was as shallow as 6 inches. The B horizon was not as variable and in some places was poorly developed. The C horizon was as close to the surface as 15 inches but in most cases was at a depth of 24 inches or more. Rocks occurred throughout the profile.

The texture of the soil was a loam or silt loam and in every case bordered the dividing line between these two classes (Table 3). Soil

Table 3. Average soil data under oak, maple, and herbaceous vegetative types.

	Depth in inches			
	0-6	6-12	12-18	18-24
Mechanical analysis				
% Sand	34.7	36.5	37.9	38.2
% Silt	53.3	49.2	46.4	44.7
% Clay	11.9	14.3	15.7	17.1
Soil type	Silt Loam	Loam	Loam	Loam
pH	6.6	6.5	6.5	6.7
Soluble salts (ppm)	150.7	124.8	148.9	171.1
Cation exchange (me/100 gms)	40.3	31.4	27.4	24.2
Ca (ppm)	768.0	631.0	574.0	547.0
Mg (ppm)	617.0	416.0	380.0	404.0
K (ppm)	379.0	172.0	103.0	71.0
Moisture equiv. (%)	31.0	25.0	24.5	22.4
Wilting point (%)	10.4	9.4	9.2	9.4

pH ranged from 5.9 to 7.4 with an average of 6.6. Generally there was little variation to a depth of 24 inches, and there was no significant difference in pH of soils under maple, oak, or herbaceous cover. Soluble salt content of the soils was comparatively low since, in most instances, they contained less than 200 ppm. The concentration was found to increase with depth with the exception of the first 6 inches which usually contained higher amounts than the 12- and 18-inch levels. Cation exchange capacities of the soils ranged from 22.5 to 42.9 meq. per 100 g of soil. They always decreased with depth being highest in the top 6 inches. The cation exchange capacity was lower in the surface soil of the herbaceous sites than it was under oak and maple where more organic matter was present. An increase in soil depth was usually accompanied by a decrease in available calcium, magnesium, and potassium. Each of these elements appeared to be relatively abundant with the possible exception of potassium at the 24-inch level (Table 3). The moisture equivalents and wilting points of the soils showed little variation under the different canopy types.

Discussion

The mountain brush-type vegetation in the canyons and on the mountain sides in the vicinity of the study area is, in most places, dominated by Gambel oak (*Quercus gambelii*). Allman's observations of the exclosure made in 1948-49 led him to conclude that maple (*Acer grandidentatum*) would eventually replace oak and serviceberry (*Amelanchier alnifolia*) in the lower ravines. Christensen (1958) studied succession in reference to growth rates of maple and oak in Pole Canyon and also concluded that maple was becoming more significant in the composition of the vegetation. The results of this study support these conclusions. On the ridge area where oak was more prominent, young maples were spreading throughout the oak. Maple freely invaded the oak brush, but it appeared that oak had difficulty invading the maple.

The reasons maple increased at the expense of the oak are still hypothetical. Christensen (1950) and Allman (1952) suggested that competition with shade-tolerant species could cause the oak to decrease. Some support for this suggestion exists since there is a greater abundance of forbs under the maple canopy than under the oak. Allman (1953) found as many as 31 different species in one five-meter-square quadrat under the maple. In this study there was an average of 19 species per quadrat in the east half which was predominantly maple and an average of 15 species per quadrat in the west half where more oaks were present. There was not only a greater variety of species present under the maple, but also the density of these species was greater. Since oak brush in the exclosure and in other areas (Moinat, 1956; Brown, 1958) has fewer herbs beneath its canopy, maple stolons and seedlings could invade this area more freely.

Both maple and oak reproduce vegetatively and by seeds. The maple, however, produces many more seeds than the oak; and ap-

parently these seeds are not as subjected to biotic influences as are the oak acorns (Christensen, 1955). Seedling data has indicated that maple is quite efficient in reproducing by seed, especially in new areas, giving it a decided advantage over oak brush in reproductive potential (Christensen and Nixon, 1964).

Among other woody species in the exclosure, serviceberry was the only one which changed markedly. The fact that serviceberry increased 14 per cent in frequency and that there were many seedlings and young plants present is evidence that it may continue to increase in the future. Cottam and Evans (1945) reported a density of .39 for serviceberry in an ungrazed canyon and a density of .19 in a grazed canyon (the term density, as used by Cottam and Evans, represents percentage of plant cover obtained by the point-observation-plot method).

The exclusion of grazing has brought about various changes in the forbs and grasses of the exclosure. Undesirable species such as mullein (*Verbascum thapsus*) and dandelion (*Taraxacum officinale*) decreased considerably in frequency. The increase of annuals and small perennials denoted one of the interesting changes. The annuals, nemophila (*Nemophila breviflora*), bedstraw (*Galium aparine*), and the winter annual blue-eyed Mary (*Collinsia parviflora*), increased considerably in frequency. Small perennials such as spring beauty (*Claytonia lanceolata*), dog-tooth violet (*Erythronium grandiflorum*), and waterleaf (*Hydrophyllum capitatum*) also increased markedly. McKell (1950) found that annual plants increased greatly the first season after a fire in the mountain brush vegetation but that perennials were slower in their recovery. The increase of larger perennials such as Engelmann aster (*Aster Engelmanni*), sweet anise (*Osmorhiza divaricata*), and figwort (*Scrophularia occidentalis*) has been slow. The large perennial forbs are generally found among the more open-type vegetation such as the tall maples. Therefore, their increase will probably accompany the increase in maple.

Kentucky bluegrass (*Poa pratensis*) spread under the tall maple and into the open areas. In Colorado, Moinat (1956) reported that Kentucky bluegrass was the dominant plant under the oak. Cottam and Evans (1945) found that the density of the palatable grasses, mountain brome (*Bromus carinatus*), Kentucky bluegrass, and Sandberg bluegrass (*Poa secunda*), was five times greater in an ungrazed canyon than in a grazed canyon. Sandberg bluegrass increased in this study, but mountain brome decreased in frequency. Ellison and Houston (1958) found that production of *Bromus carinatus* in aspen openings was greater than under aspen canopy. Their results also showed an increase of production with increase in altitude. The altitudinal location of the exclosure is probably near the lower limits of the distribution of this grass. The decrease of western wheatgrass (*Agropyron smithii*) was one of the greatest changes. Its high frequency at the time of the preliminary study is evidence that it can compete under grazing conditions. Moinat (1956) and Brown (1958) noted that western wheatgrass was the dominant grass in the

openings between the oak, but it produced very little under the oak.

The exclosure received a total precipitation of 16.18 inches, most of which arrived during the winter months. The summer storms were of light intensity and occurred at fairly long intervals. This resulted in one of the driest summers in Utah history. Only 3.09 inches of rainfall fell from May 14 to November 7. Price and Evans (1937) recorded 7.01 inches in Ephraim Canyon, and Allman (1952) registered 7.79 inches of rain from May 14 to August 25. Allman also found that precipitation measured in the exclosure during a ten-month period amounted to 22.57 inches. This was one of the wettest years in Utah history. Baker and Korstian (1931), Price and Evans (1937), Lull and Ellison (1950), Moinat (1956), and Brown (1958) recorder measurements between 15 and 20 inches of precipitation for oak brush areas.

Soil results indicated that conditions were generally favorable for plant growth. The findings were usually similar to those of Allman (1953) and, in some instances, comparable to Baker and Korstian's (1931) and to Price's (1938) results from mountain brush areas. Although soil characteristics varied, there were no significant differences under the various canopy types.

List of References

Allman, V. P. 1952. A preliminary study of the vegetation in an exclosure in the chaparral of the Wasatch Mountains, Utah. M.S. thesis, Brigham Young University.

———. 1953. A preliminary study of the vegetation in an exclosure in the chaparral of the Wasatch Mountains, Utah. Proc. Utah Acad. Sci., Arts, and Letters, 30:63-73.

Baker, F. S. and C. F. Korstian. 1931. Suitability of brushlands in the intermountain region for the growth of natural or planted western yellow pine forest. U. S. Dept. Agr. Tech. Bull., 256:1-82.

Brown, H. E. 1958. Gamble oak in west central Colorado. Ecology, 39:317-327.

Christensen, E. M. 1950. Distributional observations of oak brush (*Quercus gambelii*) in Utah. Proc. Utah Acad. Sci., Arts, and Letters, 27:22-25.

———. 1955. Ecological notes on the mountain brush in Utah. Proc. Utah Acad. Sci., Arts., and Letters, 32:107-111.

———. 1958. Growth rates and vegetation change in the oak-maple brush in lower Provo Canyon, Utah. Proc. Utah Acad. Sci., Arts, and Letters, 35: 167-168.

Christensen, E. M. and E. S. Nixon. 1964. Observations on reproduction of bigtooth maple. Leafl. Western Bot., 10:97-99.

Cottam, W. P. and F. R. Evans. 1945. A comparative study of the vegetation of grazed and ungrazed canyons of the Wasatch Range, Utah. Ecology, 26:171-181.

Ellison, L. and W. R. Houston. 1958. Production of herbaceous vegetation in openings and under canopies of western aspen. Ecology, 39:337-345.

Lull, H. W. and L. Ellison. 1950. Precipitation in relation to altitude in central Utah. Ecology, 31:479-484.

McKell, C. M. 1950. A study of succession in the oak brush (*Quercus gambelii*) zone after fire. M.S. thesis, University of Utah.

Moinat, A. D. 1956. Comparative yields of herbage from oak scrub and interspersed grassland in Colorado. Ecology, 37:852-854.

Price, R. 1938. Artificial reseeding on oak brush range in central Utah. U. S. Dept. Agr. Circ., 458:1-18.

Price, R. and R. B. Evans. 1937. Climate of the west front of the Wasatch Plateau in central Utah. U. S. Monthly Weather Rev., 65:291-301.

PREDACEOUS-SCAVENGER ANTS IN UTAH

D Elden Beck[1], Dorald M. Allred[1], and William J. Despain[2]

Introduction

During the last twenty years the Brigham Young University Department of Zoology and Entomology has sponsored extensive field surveys throughout Utah to collect parasitic arthropods. In most instances this involved trapping the host. While in the traps many small rodents were preyed upon by ants, especially during the night. This report is a summary of data accumulated over the years on the predaceous activities of these ants. Those which we have considered as predaceous-scavengers in the following pages are arranged first in phylogenetic sequence, then alphabetically with dates of collection, localities, numbers of specimens, and prey associates listed by specific name (Table 1).

Our use of the term predaceous-scavenger refers to those ants for which we have actual evidence of their eating on the body of a live animal or one recently killed. It does not include ants in defensive or protective action.

In this study rodents were most often collected with Museum Special snap traps. Traps were set out and baited in early evening and retrieved early the following morning. Occasionally a trapline was checked during the night. When animals were found with ants eating them, the ants were placed in a paper bag along with the prey. Cotton soaked in chloroform was used to kill the ants which were then placed in vials containing 70 percent ethyl alcohol, and a label showing field number, locality, prey, date and collector was added. Further details on all collections were recorded in a field book.

All ants were identified by Dr. A. C. Cole, University of Tennessee, to whom we are grateful for this courtesy. During periods of the natural history surveys involving parasitic arthropods, some research projects were supported by the National Institutes of Health (Contracts E-103, E-1273, and AI-01273-8). Gratitude is expressed for this support. In the main, however, the collections were accumulated by field surveys supported by the Brigham Young University Department of Zoology and Entomology. Students and colleagues too numerous to mention have been associated with the field operations. Their valuable services are greatly appreciated.

Literature Review

The only extensive studies of ants in Utah are by Rees and Grundmann (1940) of the University of Utah, Cole (1942) of the University of Tennessee, and Olsen (1934) of Colorado State Univer-

1. Staff members, Department of Zoology and Entomology, Brigham Young University.
2. Graduate student, Department of Zoology and Entomology, Brigham Young University.

TABLE 1: Alphabetical listing of species of predaceous-scavenger ants in Utah showing dates of collection, localities, numbers of specimens, and prey.

Species of Ant	Date	Specific Locality & County		Prey
Acanthomyops claviger	24/6/51	Joy, Juab	9	*Perognathus longimembris*
Aphenogaster subterranea occidentalis	24/6/53	Blacksmiths Fork R.S., Cache	10	*Peromyscus maniculatus*
" " "	12/7/52	Morgan, Morgan	20	" "
" " valida	20/6/52	Locomotive Spgs., Box Elder	8	*Perognathus parvus*
" " "	17/7/53	Pine Valley, Washington	25	*Peromyscus maniculatus*
Camponotus sp.	1/7/53	Currant Creek, Wasatch	6	" "
" *herculeanus modoc*	27/7/60	Scofield, Carbon	5	" "
" " "	1/8/51	Mt. Pleasant, Sanpete	15	*Eutamias quadrivittatus*
" " "	21/8/51	Pleasant Creek, Sanpete	3	*Peromyscus maniculatus*
" *vicinus*	11/6/53	Bridgeport, Daggett	15	" "
" "	18/6/52	Lucin, Box Elder	5	*Dipodomys microps*
" "	10/7/58	Dead Horse Point, Wayne	5	*Peromyscus maniculatus*
" "	27/7/51	Mercur, Tooele	1	" "
" "	30/7/58	Koosharem, Sevier	1	*Eutamias quadrivittatus*
" "	1/8/51	Mt. Pleasant, Sanpete	6	*Peromyscus maniculatus*
" "	7/8/52	Torrey, Wayne	3	" "
" "	10/8/52	Paradise Valley, Sevier	34	" "
" "	12/8/53	Callao, Juab	3	" "
" "	13/8/53	"	5	" *truei*
" "	14/8/53	Gandy, Millard	2	" *maniculatus*
" "	"	"	2	*Dipodomys ordii*
" "	7/9/51	Navajo Wells, Kane	1	*Peromyscus truei*
" *sansbeanus torrefactus*	28/8/53	Mexican Water, San Juan	1	" *crinitus*
Crematogaster depilis	17/4/52	Beaver Dam Wash., Washington	19	" *eremicus*
" "	"	"	1	*Onychomys torridus*
" "	7/7/60	Pleasant Creek, Wayne (Floral Ranch)	100	*Eutamias* sp.
" "	5/9/51	Toquerville, Washington	2	*Peromyscus eremicus*
" "	"	"	10	*Perognathus parvus*
" *lineolata emeryana*	28/5/53	Chimney Rock Pass, Utah	3	*Peromyscus maniculatus*
" " "	10/7/52	Minersville, Beaver	38	" "
" " "	13/8/53	Callao, Juab	16	*Lepus californicus*
" " "	20/8/52	Locomotive Spgs., Box Elder	2	*Peromyscus maniculatus*

Species of Ant	Date	Specific Locality & County		Prey
" *punctulata*	7/6/55	Montezuma Creek, San Juan	13	" "
" "	15/7/53	Diamond Valley, Washington	25	" "
" "	"	"	20	" *eremicus*
" "	7/9/51	Navajo Wells, Kane	8	*Dipodomys ordii*
" *minutissima*	15/7/53	Diamond Valley, Washington	5	*Peromyscus eremicus*
" *mormonum*	14/8/58	Frisco, Beaver	25	" *maniculatus*
" "	27/8/58	Swasey Spgs., Millard	12	" *truei*
" "	29/8/58	Joy, Juab	3	*Perognathus parvus*
" "	"	Koosharem, Sevier	6	*Peromyscus maniculatus*
Dorymyrmex bicolor	10/7/58	Adairville, Kane	5	" "
" "	12/8/53	Callao, Juab	5	" "
" *pyramicus*	1/4/49	Provo, Utah	15	*Rattus norvegicus*
" "	10/6/60	Hanksville, Wayne	35	*Perognathus parvus*
" "	10/6/55	Hite, Garfield	25	*Peromyscus crinitis*
" "	26/6/52	Kingston, Piute	9	" *maniculatus*
" "	2/7/60	Goblin Valley, Emery	50	" "
" "	13/7/53	Rockville, Washington	40	*Dipodomys ordii*
" "	15/7/53	Diamond Valey, Washington	6	*Perognathus formosus*
" "	22/7/51	Yuba Reservoir, Sanpete	30	*Dipodomys microps*
" "	7/8/52	Torrey, Wayne	20	*Peromyscus maniculatus*
" "	13/8/51	Duchesne, Duchesne	20	" "
" "	13/8/58	Desert Range Exp. Sta., Millard	1	*Dipodomys microps*
" "	14/8/51	Dinosaur Nat. Mon., Uintah	64	*Peromyscus maniculatus*
" "	14/8/58	Frisco, Beaver	8	*Perognathus* sp.
" "	20/8/52	Fruita, Wayne	50	*Ammospermophilus leucurus*
" "	22/8/52	Roosevelt, Duchesne	14	*Peromyscus maniculatus*
" "	"	"	33	*Dipodomys ordii*
" "	"	Huntington, Emery	15	" "
" "	5/9/51	Toquerville, Washington	5	*Peromyscus eremicus*
Formica sp.	10/6/53	Red Creek, Daggett	2	*Reithrodontomys megalotis*
" *cinerea lepida*	26/4/52	Lehi, Utah	1	" "
" " "	8/6/55	Montezuma Creek, San Juan	74	*Dipodomys ordii*
" *criniventris*	10/8/52	Paradise Valley, Sevier	5	*Peromyscus maniculatus*
" *fusca*	17/8/53	Pine Valley, Washington	5	" "
" "	24/9/53	Pleasant Creek, Sanpete	15	*Thomomys talpoides*

Species of Ant	Date	Specific Locality & County		Prey
" *integra haemorrhoidalis*	23/6/58	Deep Creek, Daggett	1	*Microtus* sp.
" " "	27/7/51	Mercur, Tooele	105	*Peromyscus maniculatus*
" " "	"	"	60	*Reithrodontomys megalotis*
" " "	29/7/60	Scofield, Carbon	4	*Eutamias quadrivittatus*
" *limata*	31/7/58	Koosharem, Sevier	3	*Peromyscus maniculatus*
" "	"	Adairville, Kane	2	*Dipodomys ordii*
" *neorufibarbis gelida*	1/7/52	Geyser Pass, LaSal Mts., San Juan	2	*Ochotona princeps*
" " "	8/8/58	Mt. Timpanogos, Emerald Lake, Utah	3	*Peromyscus maniculatus*
" " "	13/8/53	Callao, Juab	20	" "
" *neoclara*	10/6/60	Hanksville, Wayne	35	" "
" *perpilosa*	7/6/60	Pleasant Creek, Wayne	25	" "
" "	10/6/60	Cottonwood Canyon, Kane	6	" "
" "	30/6/60	San Raphael River, Emery	100	" "
" *pruinosa*	18/6/52	Lucin, Box Elder	6	*Dipodomys ordii*
" "	12/7/52	Morgan, Morgan	27	*Peromyscus maniculatus*
" *obscuripes*	12/6/53	Radosavich Ranch, Daggett	15	" "
" "	24/6/53	Monte Cristo R.S., Rich	10	*Eutamias quadrivittatus*
" "	31/7/58	Koosharem, Monroe Mt., Sevier	6	*Peromyscus maniculatus*
" "	21/8/52	Randolph, Rich	5	*Perognathus parvus*
Iridomyrmex pruinosum analis	7/6/55	Montezuma Creek. San Juan	5	*Ammospermophilus leucurus*
" " "	8/7/60	Bluff, San Juan	13	*Eutamias umbrinus*
" " "	1/9/50	Moab, Grand	1	*Neotoma lepida*
Lasius sp.	4/7/55	Provo, Utah	1	California quail
" *alienus*	17/7/53	Pine Valley, Washington	5	*Peromyscus maniculatus*
" *crypticus*	7/6/60	Pleasant Creek, Wayne	50	" "
" "	25/6/53	Woodruff, Rich	27	*Spermophilus lateralis*
" "	1/7/52	Geyser Pass, LaSal Mts., San Juan	6	*Thomomys talpoides*
" "	28/8/53	Mexican Water, San Juan	35	*Peromyscus maniculatus*
" *niger*	8/5/60	Pleasant Creek, Wayne	50	" "
" "	23/5/53	Lucin, Box Elder	25	*Reithrodontomys megalotis*
" "	8/6/60	Pleasant Creek, Wayne	50	*Marmota flaviventris*
" "	18/6/53	Woodland, Wasatch	10	*Zapus princeps*
" "	11/7/53	Pink Dunes, Kane	63	*Dipodomys ordii*
" "	9/8/52	Elkhorn R.S., Thousand Lake Mt., Wayne	2	*Peromyscus maniculatus*
" "	27/8/53	Red Mesa, San Juan	50	*Dipodomys ordii*

Species of Ant	Date	Specific Locality & County		Prey
" *sitkaensis*	7/6/60	Pleasant Creek, Wayne	38	*Peromyscus truei*
" "	10/6/53	Red Creek, Daggett	10	" *maniculatus*
" "	2/7/53	Wallsburg, Wasatch	9	*Eutamias quadrivittatus*
" "	"	"	20	*Peromyscus maniculatus*
" "	23/7/53	Koosharem, Monroe Mt., Sevier	20	" "
" "	27/7/60	Scofield, Carbon	50	" "
" "	2/8/51	Mt. Pleasant, Sanpete	30	" "
" "	22/8/51	Aspen Grove, Mt. Timpanogos, Utah	1	" "
Leptothorax muscorum	7/8/58	Emerald Lake, Mt. Timpanogos, Utah	8	" "
Monomorium minimum	9/6/51	Huntington, Emery	2	*Dipodomys ordii*
" "	11/7/52	Echo, Summit	6	*Peromyscus maniculatus*
" "	13/8/53	Callao, Juab	100	" *truei*
Myrmica brevinodis discontinua	17/7/53	Pine Valley, Washington	5	*Microtus montanus*
" " "	27/7/60	Scofield, Carbon	5	*Peromyscus maniculatus*
" " "	22/8/52	Laketown, Rich	9	*Microtus montanus*
" *lobicornis fracticornis*	12/6/53	Radosavich Ranch, Daggett	5	*Peromyscus maniculatus*
" " "	1/7/53	Currant Creek, Wasatch	4	" "
" " "	17/7/53	Pine Valley, Washington	5	" "
" " "	28/7/60	Colton, Utah	30	" "
" " "	31/7/58	Adairville, Kane	5	*Dipodomys ordii*
" " "	22/8/52	Laketown, Rich	13	*Perognathus parvus*
Myrmecocystus mexicanus hortideorum	7/6/60	Pleasant Creek, Wayne	15	*Peromyscus maniculatus*
" " "	7/6/55	Montezuma Creek, San Juan	5	" *truei*
" " "	8/6/51	Price, Carbon	1	" *maniculatus*
" " "	30/6/60	San Raphael River, Emery	50	" *crinitis*
" " "	10/7/58	Adairville, Kane	5	" *maniculatus*
" " "	15/7/53	Pine Valley, Washington	21	" *eremicus*
" " "	27/7/53	Red Mesa, San Juan	30	" *maniculatus*
" " "	10/8/52	Minersville, Beaver	1	*Neotoma lepida*
" " "	12/8/53	Callao, Juab	1	*Dipodomys microps*
" " "	26/8/53	Four Corners, San Juan	1	*Perognathus apache*
" " "	28/8/53	Mexican Water, San Juan	4	" "
" *pyramicus*	"	"	5	*Onychomys leucogaster*
" "	"	"	5	*Peromyscus boylii*
" *mojave*	23/5/53	Lucin, Box Elder	3	" *maniculatus*

Species of Ant	Date	Specific Locality & County		Prey
" "	8/6/51	Price, Carbon	3	" "
Paratrechina sp.	28/8/53	Mexican Water, San Juan	4	*Neotoma* sp.
" "	26/8/53	Four Corners, San Juan	3	*Perognathus apache*
Pheidole sp.	17/3/52	Beaver Dam Wash., Washington	1	" *longimembris*
" "	19/6/52	Lucin, Box Elder	6	" sp.
" "	12/7/52	Morgan, Morgan	2	*Eutamias minimus*
" "	15/7/53	Diamond Valley, Washington	25	*Peromyscus maniculatus*
" *ceres*	11/7/52	Echo, Summit	15	" "
" *bicarinata*	7/4/51	Navajo Wells, Kane	1	" "
" "	13/5/53	Jensen, Uintah	9	" "
" "	7/6/55	Montezuma Creek, San Juan	50	" *crinitis*
" "	8/6/55	"	18	" *truei*
" "	10/6/58	Cottonwood Creek, Kane	16	" *maniculatus*
" "	19/6/52	Lucin, Box Elder	1	*Dipodomys ordii*
" "	24/6/51	Navajo Wells, Kane	4	*Neotoma lepida*
" "	12/7/53	Short Creek, Washington	50	*Dipodomys ordii*
" "	13/7/53	Rockville, Washington	35	*Perognathus formosus*
" "	16/7/53	Diamond Valley, Washington	9	" "
" "	18/7/53	"	5	*Peromyscus maniculatus*
" "	13/8/58	Desert Range Exp. Sta., Millard	40	*Perognathus longimembris*
" "	"	"	18	*Peromyscus maniculatus*
" "	14/8/58	Frisco, Beaver	20	*Dipodomys ordii*
" "	22/8/53	Four Corners, San Juan	100	*Peromyscus truei*
" "	28/8/53	Roosevelt, Uintah	25	*Rattus norvegicus*
" "	5/9/51	Toquerville, Washington	30	*Neotoma lepida*
" "	6/9/51	Grafton, Washington	15	*Perognathus parvus*
" "	8/9/51	Adairville, Kane	15	*Dipodomys ordii*
" *dentata*	5/9/51	Toquerville, Washington	5	*Perognathus parvus*
" *hyatti*	11/6/58	Adairville, Kane	1	*Peromyscus maniculatus*
" "	13/7/53	Rockville, Washington	20	" *eremicus*
" "	6/9/51	Grafton, Washington	4	*Dipodomys merriami*
Pogonomyrmex occidentalis	15/6/53	Radosavich Ranch, Daggett	10	*Eutamias* sp.
" "	8/9/51	Adairville, Kane	5	*Dipodomys ordii*
Solenopsis molesta validiuscula	9/6/51	Soldier Summit, Wasatch	12	*Spermophilus armatus*
" " "	10/6/53	Jensen, Uintah	5	*Dipodomys ordii*

Species of Ant	Date	Specific Locality & County	Prey	
" " "	4/7/55	Provo, Utah	11	California quail
" " "	15/7/53	Diamond Valley, Washington	5	*Peromyscus maniculatus*
" " "	6/9/51	Navajo Wells, Kane	14	*Neotoma lepida*
" " "	9/11/51	Rush Valley, Tooele	1	" "
" " "	23/2/52	Beaver Dam Wash, Washington	2	" "
Tapinoma sessile	9/6/55	Kigalia R.S., San Juan	50	*Eutamias minimus*
" "	10/6/60	Hanksville, Wayne	50	*Peromyscus maniculatus*
" "	12/6/53	Radosavich Ranch, Daggett	5	" "
" "	20/6/52	Locomotive Springs, Box Elder	5	*Neotoma lepida*
" "	4/7/55	Provo, Utah	10	California quail
" "	14/7/52	Echo, Summit	25	*Peromyscus maniculatus*
" "	14/7/53	Leeds, Washington	50	" "
" "	17/7/53	Pine Valley, Washington	17	*Microtus montanus*
" "	18/7/53	Enoch, Iron	10	*Dipodomys ordii*
" "	2/8/53	Johnny Star Flat, Duchesne	25	*Peromyscus maniculatus*
" "	"	"	27	*Eutamias minimus*
" "	5/9/51	Toquerville, Washington	5	*Perognathus parvus*

sity. Although these studies include a large listing of ant species for the state, little is mentioned about their feeding habits.

Creighton's work (1950) on the ants of North America makes general references to food habits for some species, and in a few instances gives specific reference to others. Several direct references involve species that we have observed, whereas others relate to species not known from Utah. Some of Creighton's data related to scavenger-predaceous species are quoted below, followed by our comments.

> "*Platythyrea punctata* (F. Smith): The workers are active and forage singly. The colonies are small consisting of from fifty to two hundred individuals. It is both carnivorous and predatory" (p. 34).

This species occurs in the extreme southern part of the United States.

> "*Cerapachys augustae* Wheeler: It is virtually certain that these ants are carnivorous, and it is probable that they are predaceous" (p. 58).

The range of this species is from western Texas to southern Arizona.

> "At certain seasons these insects [ants of subfamily Dorylinae] become nomadic, and the entire colony sets out on an expedition which becomes a series of raids against animals that may happen to be in the vicinity . . . although there has been much exaggeration of the capacity of these insects for attacking large vertebrates. Undoubtedly, they would do so if given the opportunity, but unless the animal was badly crippled or comatose, it could easily avoid the attack. The main victims of these raids are other insects which are secured in prodigious numbers" (p. 60).
>
> "There is a persistent belief that in the days when the West was wilder than it is now, Indians would sometimes stake out a human victim across a nest of *Pogonomyrmex*. If this was actually done it would be hard to imagine a more excruciating death" (p. 110).

We observed *Pogonomyrmex occidentalis* demonstrating the scavenger-predaceous habit in only two instances, yet it is one of the most widely distributed ants in Utah. It has a ferocious habit of attacking and stinging a victim as a protective action. The sting is painful to humans.

> "Despite their preference for a graminivorous diet, many species of *Pheidole* will accept other food as well. They seem less attracted to honey-dew than do many ants but will often feed voraciously on animal tissue when the opportunity offers" (p. 161).

We have records of four species of *Pheidole* being scavenger-predaceous in habit. They are *P. ceres*, *P. bicarinata*, *P. dentata* and *P. hyatti*.

> "Because of their omnivorous habits, they [*Solenopsis geminata* and *S. saevissima*] are always turning up in unexpected situations. They have been known to damage the buds and tender twigs of young fruit trees and kill quail which are too young to leave the nest" (p. 227).

We observed *Solenopsis molesta validiuscula* as a scavenger-predator. These ants are the popularly known Fire Ants, a name

given to them because of their painful sting. We included this reference because Creighton mentions the term omnivorous; to kill does not mean the ant is a predator or scavenger.

> "The ants [*Dorymyrmex pyramicus* and *D. bicolor*] are very active and predaceous but will feed on honey-dew when thy can get it. They have a strong odor of butyric acid which is particularly noticeable when they are crushed" (p. 348).

Dorymyrmex pyramicus and *D. bicolor* definitely are predaceous-scavengers.

> "Of *Myrmecocystus* . . . a considerable proportion of the species . . . appear to be carnivorous" (p. 354).

We found this to be true for *M. mexicanus hortideorum*, *M. pyramicus* and *M. mojave*.

Results

The taxonomic arrangement of subfamilies and genera follows that of Creighton (1950). In a few instances in the list below. only generic determination was possible.

Subfamily Myrmicinae

Myrmica brevinodis discontinua Weber
Myrmica lobicornis fracticornis Emery
Pogonomyrmex occidentalis (Cresson)
Aphenogaster subterranea valida Wheeler
Aphenogaster subterranea occidentalis (Emery)
Pheidole sp.
Pheidole ceres Wheeler
Pheidole bicarinata Mayr
Pheidole dentata Mayr
Pheidole hyatti Emery
Crematogaster depilis Wheeler
Crematogaster lineolata emeryana Creighton
Crematogaster punctulata Emery
Crematogaster minutissima Mayr
Crematogaster mormonum Emery
Monomorium minimum (Buckley)
Solenopsis molesta validiuscula Emery
Leptothora muscorum (Nylander)

Subfamily-Dolichoderinae

Iridomyrmex pruinosum analis (E. Andre)
Dorymyrmex bicolor (Wheeler)
Dorymyrmex pyramicus (Roger)
Tapinoma sessile (Say)

Subfamily-Formicinae

Camponotus sp.
Camponotus herculeanus modoc Wheeler
Camponotus sansabeanus torrefactus Wheeler
Camponotus vicinus Mayr
Paratrechina sp.
Lasius sp.
Lasius alienus Mayr
Lasius crypticus Wilson
Lasius niger Mayr
Lasius sitkaensis Pergande
Acanthomyops claviger (Roger)
Myrmecocystus mexicanus hortideorum McCook
Myrmecocystus mojave Wheeler
Myrmecocystus pyramicus Smith
Formica sp.
Formica cinerea lepida Wheeler
Formica criniventris Wheeler
Formica fusca Linné
Formica integra haemorrhoidalis Emery
Formica limata Wheeler
Formica neoclara Emery
Formica neorufibarbis gelida Wheeler
Formica perpilosa Wheeler
Formica pruinosa Wheeler
Formica obscuripes Forel

Table 1 lists the species collected, dates of collection, specific localities (towns or other geographic locations), counties, numbers of specimens collected, and animals upon which the ants were feeding. Dates of collections are arranged by day, month and year. When a species was collected several times during the year, the dates are listed in chronological order.

Six species were found only in the Great Basin, fourteen in the Colorado River Drainage Basin, and twenty-four species were generally distributed in both basins. See Table 2.

For the most part, small rodents were the animals upon which the ants were observed feeding. In a few instances rabbits were involved. Occasionally small ground-dwelling birds were caught and killed in snap traps, and ants preyed upon them. In other cases ants invaded the nests of rodents and attacked their young.

TABLE 2

Geographic Distribution

Great Basin Only	Colorado River Basin Only	Both Basins
Acanthomyops claviger	*Camponotus sansabeanus torrefactus*	*Aphenogaster subterranea valida*
Aphenogaster subterranea occidentalis	*Crematogaster depilis*	*Camponotus vicinus*
Crematogaster lineolata emeryana	*Crematogaster punctulata*	*Camponotus herculeanus modoc*
Crematogaster mormonum	*Crematogaster minutissima*	*Dorymyrmex bicolor*
Formica pruinosa	*Formica criniventris*	*Dorymyrmex pyramicus*
Pheidole ceres	*Formica neoclara*	*Formica cinerea lepida*
	Formica perpilosa	*Formica fusca*
	Iridomyrmex pruinosum analis	*Formica integra haemorrhoidalis*
	Lasius alienus	*Formica limata*
	Myrmecocystus pyramicus	*Formica neorufibarbis gelida*
	Paratrechina sp.	*Formica obscuripes*
	Pheidole dentata	*Lasius crypticus*
	Pheidole hyatti	*Lasius niger*
	Pogonomyrmex occidentalis	*Lasius sitkaensis*
		Leptothorax museorum
		Monomorium minimum
		Myrmica brevinodus discontinua
		Myrmica lobicornis fracticornis
		Myrmecocystus mexicanus hortideorum
		Myrmecocystus mojave
		Pheidole sp.
		Pheidole bicarinata
		Solenopsis molesta validiuscula
		Tapinoma sessile

Discussion

In the several studies of ants of Utah the schemes of classification have varied. In so far as we can determine from the literature, approximately 126 kinds of ants combined under species, subspecies, and a variety of other categories are known for Utah. We list 42 kinds representing 41 species in 17 genera. The genus *Paratrechina* was the only one for which specific identification could not be made.

The following 23 species and subspecies and one genus are herein reported from Utah for the first time: *Acanthomyops claviger*, *Aphaenogaster subterranea valida*, *Camponotus vicinus*, *Crematagaster depilis*, *C. lineolata emeryana*, *C. punctulata*, *C. minutissima*, *Formica cinerea lepida*, *F. integra haemorrhoidalis*, *F. limata*, *F. neorufibarbis gelida*, *F. neoclara*, *Lasius alienus*, *L. crypticus*, *Leptothorax muscorum*, *Myrmica brevinodis discontinua*, *Myrmecocystus pyramicus*, *M. mojave*, *Paratrechina* sp., *Pheidole ceres*, *P. bicarinata*, *P. dentata*, and *P. hyatti*. It is unusual to have more than half of our collections represent new distribution records.

In many years of field surveys, and especially those involved with parasitic arthropod investigations, we have sampled most of the major types of ecological situations which occur in Utah. This may account in part for the many new distributional records.

Of the approximate 126 kinds of ants previously reported, 19 have been found by us to be predaceous-scavengers. This indicates that the 107 other kinds do not have this habit, or we have failed to discover such activities for these species. Although the latter is possible, it seems unlikely when one considers the number of years involved in our surveys and the thousands of animals trapped in varying types of habitats.

One should not classify an ant as a predaceous-scavenger kind if the ant simply assumes a defensive or protective action. Such a defensive pose is taken when *Pogonomyrmex occidentalis* is disturbed. One of the most abundant ants in Utah, this insect is responsible for mounds scattered throughout the valleys and foothills. Yet, our records show only two instances where this species was observed consuming animal flesh.

Those ants which we consider as predaceous-scavengers and are widespread in Utah are *Camponotus vicinus*, *Dorymyrmex pyramicus*, *Lasius niger*, *Myrmecocystus mexicanus hortideorum*, *Pheidole bicarinata*, and *Tapinoma sessile*. Some forms, such as *Iridomyrmex pruinosum analis* which was encountered only in the southeastern part of Utah in lowland desert situations, could be considered geographically restricted. Creighton (1950:343) stated that "the northern limit of the range appears to lie in southern Idaho." Although not restricted to any part of Utah, *Lasius sitkaensis* occurs at higher elevations on mountains, in canyons and in valleys.

There is little evidence that any of the ants observed in this study are prey-specific in their association. We have trapped a number of species of rodents in high mountain situations many times over the

years. At these higher elevations the numbers of species of predaceous-scavenger ants are comparatively fewer than at lower elevations and in the desert.

Geographic distributional records were included only for our collections. Seasonal collecting on a year-round schedule in localities ecologically similar and at similar altitudes is desirable. Collection data certainly are not complete, for example, when records for *Pogonomyrmex occidentalis* are known only from two localities at opposite ends of the state. The same is true for other species such as *Formica neorufibarbis gelida* which shows only an extreme east and west distribution.

Bibliography

Cole, A. C., Jr. 1942. The Ants of Utah. Amer. Midland Nat., 28(2): 358-388.

Creighton, W. S. 1950. The Ants of North America. Bull. Mus. Comp. Zool. Harvard College, v. 104.

Olsen, W. O. 1934. Notes on the North American Harvesting Ants of the Genus *Pogonomyrmex* Mayr. Bull. Mus. Comp. Zool., Harvard College, v. 78(8).

Rees, D. M. and A. W. Grundmann. 1940. A Preliminary List of the Ants of Utah. Bull. Univ. Utah, Biol. Ser., 6(2).

NEW RECORDS AND SPECIES OF NEOTROPICAL BARK BEETLES (SCOLYTIDAE: COLEOPTERA)[1]

Stephen L. Wood[2]

While preparing a taxonomic review of the bark and ambrosia beetles (Scolytidae) of Costa Rica, it was necessary to examine all available species of this group from Mexico, all of Central America, and northern South America. As a result, a large number of species new to science were recognized from areas outside of Costa Rica. In order to make names available for these species to facilitate this and other work, 20 species new to science are described below. The new species represent the genera *Cnesinus* (11), *Leperisinus* (1), *Chramesus* (5), *Phloeotribus* (1), and *Chaetophloeus* (2). The type series of these species were collected in the following countries: Mexico (7), Guatemala (4), Honduras (3), Panama (4), and Colombia (2).

Cnesinus elegantis, n. sp.

This species is very closely related to *elegans* Blandford, but is easily distinguished by the larger size, by the more strongly strigose pronotum, by the more coarsely, deeply punctured declivital interspaces, and by the more distinctly striate elytral declivity.

Female.—Length 3.3 mm. (paratypes 3.0-3.4 mm.), 2.7 times as long as wide; color brown.

Frons strongly, transversely impressed at level of antennal bases, convex above, impressed area with a pair of sublateral calluses on either side of deepest point of impression, epistomal callus evident and armed by a pair of rather widely placed, large, pointed tubercles larger than those of *elegans;* surface reticulate and minutely, sparsely punctured; vestiture restricted to sides below level of antennal bases, and epistomal area, fine, hairlike; eyes separated by a distance equal to twice the greatest width of an eye.

Pronotum 1.06 times as long as wide; sides widest in front of middle; surface with closely set, deep, elongate punctures, more than half longitudinally confluent; glabrous.

Elytra 1.8 times as long as wide, 1. 9 times as long as pronotum; sides straight and subparallel to declivital base, rather broadly rounded behind; striae moderately impressed, the punctures rather small, deep, separated by distances equal to their own diameters; interstriae twice as wide as striae, the punctures variable in size, rather confused. Declivity rather steep, impressed between third interspaces; striae not impressed, the punctures clearly, rather deeply impressed; interspace 1 moderately elevated, 2 flat and wider than 1 or 3; all

1. Part of the field work relating to this study was sponsored by a research grant from the National Science Foundation, No. GB-532.

2. Department of Zoology and Entomology, Brigham Young University, Provo, Utah. Scolytoidea Contribution No. 34.

interspaces armed by a few fine, rounded, irregularly placed granules. Vestiture largely confined to declivity, consisting of long, rather fine interstrial bristles, and shorter strial and interstrial hair; the longest bristles equal in length to combined widths of interspaces 2 and 3.

MALE.—Similar to female except frontal callus slightly more prominent and unarmed.

TYPE LOCALITY.—Volcan Zunil, Quezaltenango Prov., Guatemala.

HOST.—*Quercus* sp.

TYPE MATERIAL.—The female holotype, male allotype, and 31 paratypes were collected from oak twigs at the type locality on May 27, 1964, at an elevation of 1,000 m., by S. L. Wood.

The holotype, allotype, and paratypes are in my collection; one paratype is in the Schedl collection.

Cnesinus bicornus, n. sp.

This species is closely related to *elegans* Blandford, but is readily distinguished by the much larger size, by the stouter body, by the broadly concave frons in both sexes, by the presence of interstrial granules on the elytral disc, and, in the female, by the much larger epistomal tubercles.

FEMALE.—Length 3.5 mm. (paratypes 3.3-3.8 mm.), 2.5 times as long as wide; color dark reddish-brown.

Frons rather deeply concave from eye to eye from vertex to epistoma, lateral margins acute below eye; epistoma armed by a pair of very large, pointed, conical spines, each longer than half of greatest width of eye; concavity on lower half with a pair of lateral calluses; surface substrigose-reticulate, with small, rather sparse, obscurely granulate punctures; vestiture fine, obscure, except a row of long and erect hairlike bristles on lateral margin; eyes separated by 2.7 times greatest width of an eye.

Pronotum 1.1 times as long as wide; sides almost straight on basal two-thirds, very slightly wider in front of middle, broadly rounded in front; surface longitudinally strigose, the punctures usually not evident, grooves dull, ridges shining; median line evident on posterior half; vestiture hairlike, inconspicuous except on all marginal areas.

Elytra 1.6 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel to declivital base, rather broadly rounded behind; striae narrowly, not strongly impressed, the punctures small, impressed; interstriae three or more times as wide as striae, subcrenulate toward base, the remaining surface shining, not clearly punctured, irregular, with small rounded granules in somewhat indefinite uniseriate rows. Declivity rather steep, convex, except flattened between third interspaces; striae 1 strongly, 2 moderately, 3 not impressed; interspaces subshining, weakly convex, about four or five or more times wider than strial punctures, each interspace with a median row of rather large rounded granules. Vestiture hairlike, more abundant but not longer on declivity; con-

sisting of median rows of fine, erect interstrial hair, and more abundant, almost equally long, semirecumbent hair; the longest setae about equal to distance between rows.

Male.—Similar to female except frontal excavation slightly shallower and less extensive; epistomal callus developed but unarmed.

Type Locality.—Thirteen miles west of Morelia, Michoacan, Mexico.

Type Material.—The female holotype, male allotype, and 43 paratypes were collected at the type locality on June 15, 1965, at an elevation of about 2,300 m., by S. L. Wood, from small stems of a large herb 2-3 m. tall.

The holotype, allotype, and paratypes are in my collection.

Cnesinus foratus, n. sp.

Closely allied to *electus* Wood, but distinguished by the much more closely, coarsely, substrigose punctures of the pronotum, by the steeper, much less strongly impressed elytral declivity, and by the narrower male epistomal callus.

Male.—Length 2.0 mm. (paratypes 2.0-2.1 mm.), 2.4 times as long as wide; color dark brown.

Frons transversely impressed at level of ocular emargination, convex above, flattened below this point; upper surface faintly, transversely strigose, shining, with sides reticulate (entire area reticulate in one paratype); lower area flattened, with a low, broad, triangular epistomal callus glabrous and shining below, a band of closely set, erect, reddish hair on upper slope, remaining area reticulate; glabrous except for epistomal brush and a single, sparse row of hair along lateral margin to upper level of eyes; eyes separated by a distance equal to about twice the greatest width of an eye.

Pronotum 1.04 times as long as wide; sides weakly arcuate on posterior half, widest at about middle, anterior margin broadly rounded; surface closely, coarsely, shallowly punctured, the punctures longitudinally confluent, the interspacial ridges occupying less than a third of surface; vestiture consisting of long, coarse bristles in marginal and median areas.

Elytra 1.6 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel to declivital base, broadly rounded behind; striae impressed, the punctures partly obscured by confluence; interstriae somewhat wider than striae, surface irregular, the punctures rather small, somewhat uniseriate, subcrenulate toward base. Declivity steep, convex; striae 1 impressed, others indicated, the punctures reduced but distinct; interspaces as wide as striae, 1 slightly elevated and subgranulate, 2 and 3 and others with a row of moderately large, rounded granules. Vestiture consisting of long, stout (subscalelike), interstrial bristles from base to apex, distance between bristles and between rows slightly less than length of a bristle.

Female.—Not represented in the material at hand.

Type Locality.—El Bosque, Caicedonia, Valles, Colombia.

Type Material.—The male holotype and four male paratypes were collected at the type locality on June 23, 1959, by J. Restrepo, from dead branches. Two other male paratypes are from Finca la Tribuna, at the same locality, taken in May, 1959, by Gregorio Vargus from coffee berries.

The holotype and paratypes are in my collection.

Cnesinus electinus, n. sp.

Very closely related to *electus* Wood but eyes much more widely separated and epistomal callus and brush more elaborately developed.

Male.—Length 2.4 mm. (paratypes 2.1-2.5 mm.), 2.7 times as long as wide; color dark brown, the elytra somewhat lighter.

Frons transversely impressed at level of eye emargination, flattened below, and convex above that point; epistomal callus broad, low, lower margin abrupt, precipitous, small triangular median area impunctate and glabrous, remaining area densely covered by a plush stand of erect, reddish bristles; convex area almost smooth, subshining, impunctate except at sides and above; vestiture scanty, limited to lateral areas except for epistomal brush; eyes separated by a distance slightly more than twice the greatest width of an eye.

Pronotum 1.1 times as long as wide; sides almost straight and parallel on anterior two-thirds, very slightly wider in front of middle, anterior margin broadly rounded; surface smooth and shining, with rather numerous, minute points and moderately large, deep, oval punctures, the punctures separated by about one-half to three times their own diameters, none confluent; vestiture sparse, inconspicuous, confined to marginal areas.

Elytra 1.7 times as long as wide, 1.7 times as long as pronotum; striae impressed, the punctures moderately large, deep; interstriae about twice as wide as striae, convex, the punctures small and staggered in indefinite, uniseriate rows, the punctures granulate on 2 and 3 near declivity and on 1 behind middle of disc. Declivity steep, impressed between third interspaces; striae 1 strongly impressed, others not impressed, the punctures moderately large and deep; interspace 1 somewhat elevated, 3 convex, 1 with fine punctures, 2 and 3 with moderately large, rounded granules. Vestiture almost restricted to declivity, consisting of uniseriate rows of erect bristles on all interspaces except 1, each bristle one to two times as long as distance between rows of bristles.

Female.—Similar to male except epistomal callus and brush more poorly developed.

Type Locality.—Fifteen miles south of Mazamitla, Jalisco, Mexico.

Type Material.—The male holotype, female allotype, and 28 paratypes were collected at the type locality on June 22, 1965, at an

elevation of about 2,400 m., by S. L. Wood, from twigs of a small tree.

The holotype, allotype, and paratypes are in my collection.

Cnesinus niger, n. sp.

This species is rather closely allied to *panamensis* Blackman, but is readily distinguished by the dorsad extension of the frontal impression, by the deeper, nonconfluent strial punctures on the elytral disc, by the more finely sculptured elytral interspaces, and by the much smaller punctures of all declivital striae.

Male.—Length 2.0 mm. (paratypes 2.0-2.5 mm.), 2.6 times as long as wide; color almost black.

Frons convex above, transversely impressed at level of occular emargination, lower half of area between impression and epistoma bearing an elevated callus, the callus almost reaching lateral margins, sharply defined above, densely pubescent on its upper slope, with a small, median, glabrous, triangular area below; surface subreticulate, shining, punctures not evident below upper level of eyes; vestiture limited to callus and a few inconspicuous setae along sides. Eyes separated above by a distance equal to about two and one-half times the greatest width of an eye.

Pronotum 1.04 times as long as wide; widest just behind middle; surface almost smooth and shining, the punctures small, rather close, almost round at base, each puncture becoming elongate anteriorly but not more than twice as long as wide, rarely confluent; glabrous behind, a few short setae on anterior third.

Elytra 1.7 times as long as wide, twice as long as pronotum; sides straight and subparallel on more than basal half, rather narrowly rounded behind; striae impressed, the punctures large, deep, clearly separated from one another; interstriae as wide as striae, the punctures fine, shallow, not strongly confused, surface subshining. Declivity rather steep, convex; interspace 1 distinctly elevated, median half of 2 flat, impressed (less obvious on left side), lateral half narrowly convex, 3 narrowly convex, 2 and 3 each bearing a row of fine granules. Vestiture confined to declivity, consisting of interstrial rows of moderately long, stout bristles, except missing on lower two-thirds of 1.

Female.—Similar to male except frontal callus and brush greatly reduced.

Type Locality.—Cerro Punta near Volcan Baru (or Chiriqui), Panama.

Type Material.—The male holotype, female allotype, and 41 paratypes were taken at the type locality on January 11, 1964, at an elevation of 1,800 m., by S. L. Wood, from the twigs of three different tree species.

The holotype, allotype, and most of the paratypes are in my collection; one paratype is in the Schedl collection.

Cnesinus myelitis, n. sp.

This species is allied to *punctatus* Blandford, but may be distinguished by the smaller size, by the more slender form, by the larger, more shallow punctures of the pronotum, and by frontal and elytral characters.

Male.—Length 2.4 mm. (paratypes 2.0-2.4 mm.), 2.4 times as long as wide; color dark brown.

Frons transversely impressed at level of occular emargination, convex above and flattened below this point; upper surface minutely, transversely aciculate to upper level of eyes, lower area subreticulate and with a large, broad epistomal callus covered by a brush of rather long, erect, reddish bristles, the entire callus setiferous, smaller and less strongly elevated than in *punctatus*.

Pronotum 1.05 times as long as wide; sides feebly arcuate on basal two-thirds, very slightly wider in front of middle, anterior margin rather broadly rounded; surface subshining, evidently with very minute points and moderately large, shallow, oval punctures, the punctures largely confluent on anterior half, rather widely separated on posterior half; subglabrous.

Elytra 1.5 times as long as wide, 1.6 times as long as pronotum; sides straight and parallel on anterior two-thirds, rather broadly rounded behind; striae rather strongly impressed, the punctures moderately large, deep; interstriae about twice as wide as striae, convex, the punctures uniseriate, fine in middle area, subcrenulate toward base, forming rather large rounded granules on posterior half of 1 and posterior fourth of 2 and 3. Declivity rather steep, convex; striae 1 strongly impressed, others not impressed; interstriae 1 convex, punctured except at top, 2 higher than 1 (except median half on right side) and bearing a row of rather large, rounded granules, 3 as high as 2 and similarly armed. Vestiture almost limited to declivity, except on interspace 1, consisting of interstrial rows of erect, tapered bristles, absent on lower three-fourths of 1; each bristle about one and one-half to two times as long as distance between rows.

Female.—Similar to male except epistomal callus and brush poorly developed.

Type Locality.—Five miles northeast of Teziutlan, Puebla, Mexico.

Type Material.—The male holotype, female allotype, and 16 paratypes were collected at the type locality on June 27, 1953, at an elevation of 1,500 m., by S. L. Wood, from a woody vine less than 1 cm. in diameter.

Cnesinus colombianus, n. sp.

Although not closely related, this species is more closely allied to *punctatus* Blandford than other species known to me. It may be distinguished from Blandford's species by the larger size, by the different sculpture of the epistomal callus, by the more coarsely sculp-

tured pronotum, by the granulate interspace 1 on elytral declivity, and by other characters.

Male.—Length 2.9 mm. (paratypes 2.8-3.2 mm.), 2.3 times as long as wide; color dark reddish-brown with elytra somewhat lighter.

Frons transversely impressed at level of occular emargination, convex above and flattened below this point; surface above completely smooth and brightly shining, with a few minute punctures laterally and toward vertex, lower area largely covered by a dense brush of reddish bristles, reticulate and punctured at sides; pubescent area with a low, sharply elevated, median carina, this carina divided on lower third of flattened areas and the two branches continued as an epistomal carina below brush but distinctly above epistomal margin, subhorizontal arms of carina smooth, shining, glabrous. Eyes separated by a distance equal to 2.2 times the greatest width of an eye.

Pronotum 0.95 times as long as wide; sides feebly arcuate on basal two-thirds, widest in front of middle, broadly rounded in front; surface coarsely, deeply punctured, most punctures longitudinally confluent except at base; vestiture restricted to marginal areas.

Elytra 1.5 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae impressed, the punctures obscured by confluence; interspaces about twice as wide as striae, surface irregular, the punctures small, confused, some finely granulate on their anterior margins. Declivity steep, convex, narrowly flattened on lower half; striae impressed, the punctures clearly evident; interstriae slightly wider than striae, convex, 1 and 3 very slightly higher than 2, each uniseriately, rather finely granulate with some punctures intermixed, 1 and 2 reaching almost to apex, 3 joining 5 and ending before 2, 4 ending just below middle of declivity. Vestiture confined to a few scattered bristles in lateral area of declivity.

Female.—Similar to male except epistomal brush reduced, and median frontal carina absent.

Type Locality.—El Bosque, Caicedonia, Valles, Colombia.

Type Material.—The male holotype, female allotype, and 24 paratypes were collected at the type locality on June 23, 1959, by J. Restrepo, from dead branches.

The holotype, allotype, and paratypes are in my collection.

Cnesinus retifer, n. sp.

This species is allied to *gracilis* Blandford, but is readily distinguished by the very strongly convex frons, by the completely reticulate pronotum and elytra, and by the confluent punctures of the declivital striae.

Adult.—Presumably a male, length 2.0 mm. (paratypes 1.9-2.0 mm.), 2.9 times as long as wide; color very dark brown, almost black.

Frons strongly convex almost to epistoma; surface coarsely reticulate, with minute, rather sparse granules; vestiture short, sparse, inconspicuous. Eye very feebly sinuate on anterior margin.

Pronotum 1.1 times as long as wide; widest two-fifths of length from anterior margin, sides straight and diverging from base, broadly rounded in front; a conspicuous, smooth, shining callus extending from anterolateral angles at widest point more than halfway toward median line just behind anterior margin; remainder of surface reticulate, dull, with rather large, shallow oval punctures in posterior area, and small, deep, elongate punctures anteriorly; anterior punctures often confluent, posterior punctures usually separate; glabrous.

Elytra 1.8 times as long as wide, 1.7 times as long as pronotum; sides straight and subparallel to base of declivity, rather narrowly rounded behind; striae moderately impressed, the punctures confluent; interstriae about one and one-half times as wide as striae, except 1 narrower, the punctures very fine, deep, uniseriate except at base of 3. Declivity convex, rather steep; interstriae narrower than striae, convex, 1 very slightly more strongly elevated. Vestiture confined to declivity, consisting of interstrial rows of flattened bristles; each bristle as long as distance between rows of bristles.

Only one sex represented in the type series.

Type Locality.—Fort Clayton, Canal Zone, Panama.

Type Material.—The holotype and five paratypes were collected at the type locality on December 22, 1963, at an elevation of about 30 m., by S. L. Wood, from the central axis of an unknown vine that was about 0.5 cm. in diameter.

The holotype and paratypes are in my collection.

Cnesinus annectens, n. sp.

According to Schedl, this species is closely allied to *guadeloupensis* Eggers. The description of Eggers' species, however, indicates that the declivital interspace 2 is narrowed and eliminated before the elytral apex. In this species it is wider than either 1 or 3 and extends to the apex. The lack of anatomical specialization makes characterization of this species difficult; however, biologically it is unique, as noted below, in that it constructs egg tunnels in the cambium rather than in the central axis of the host.

Female.—Length 2.3 mm. (paratypes 1.9-2.5 mm.), 2.2 times as long as wide; color brown with white vestiture.

Frons broadly impressed, almost concave, from upper level of eyes to epistoma, an obscure epistomal callus indicated; surface reticulate, obscurely below, coarsely above, with small indefinite punctures rather uniformly, not closely distributed; vestiture rather widely distributed in lateral areas, consisting of fine, long, yellow hair, much longer above, some setae equal to three-fourths the distance between eyes; distance between eyes equal to twice greatest width of an eye.

Pronotum 0.93 times as long as wide; very slightly wider at base, sides very feebly arcuate on about basal two-thirds, broadly rounded

in front; surface coarsely, not deeply punctured, the punctures evidently reticulate, almost all confluent, the very narrow, irregular interspaces smooth, shining; median line narrow, weakly raised from anterior fourth to base; vestiture short, abundant, fine except almost scalelike near all margins.

Elytra 1.4 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather broadly rounded behind; striae rather shallowly impressed, the punctures moderately large, deep; interspaces about twice as wide as striae, convex, the punctures small, numerous, subgranulate, in three obscure ranks. Declivity rather steep, laterally convex, impressed between third interspaces; striae and strial punctures impressed, not reduced; interstriae as wide as striae, with granules slightly larger than on disc, uniseriate, 1 and 2 continuing to apex, 3 obscured on lower third. Vestiture abundant, erect, consisting of stout interstrial bristles, median row on each interspace a third longer than ground cover, but shorter than distance between rows.

Male.—Similar to female except frontal impression shorter, not as deep, the frontal vestiture much shorter.

Type Locality.—Zamorano, Morazan, Honduras.

Host.—*Verbisina agricolorum*.

Type Material.—The female holotype, male allotype, and 116 paratypes were collected at the type locality on April 18, 1964, at an elevation of 700 m., by S. L. Wood, from the lower parts of green stems about 1-3 cm. in diameter of the host plant.

The holotype, allotype, and most of the paratypes are in my collection; two paratypes are in the Schedl collection.

Habits.—The egg tunnel was cut in the cambium region about half in the xylem and half in the phloem tissues. It was small and rather broad, much as in most *Scolytodes* species, with about three to eight large egg niches placed along one or more sides. The eggs were mixed with frass and packed into these niches. The larvae fed more or less in congress in the phloem tissues, scarcely engraving wood, until approximately the second instar was completed. The female parent in most of the older galleries had cut a tunnel from the egg chamber to the pith along the central axis of the stem. All third instar larvae present were in these pith tunnels. Larvae older than the third instar were not present in the material studied. After cutting the pith tunnel the parent adults appeared to abandon the tunnels, evidently to begin a second brood.

Cnesinus adusticus, n. sp.

This species is very similar to *adustus* Schedl, but is distinguished by the larger size, by the widely separated eyes, by the slightly deeper impression of the elytral declivity, and by the more deeply impressed striae 1 on declivity. Males only compared; an authentic female of *adustus* not at hand.

Female.—Length 2.9 mm. (paratypes 2.6-3.3 mm.), 2.4 times as long as wide; color reddish-brown, with white and cinereous vestiture.

Frons with an arcuate, sharply elevated, transverse carina at level of occular emargination occupying median third; weakly convex above, flattened below carina; most of lower area covered by a brush of erect reddish bristles; upper area minutely, transversely strigose, punctured and granulose at sides and above; lateral areas above carina and below upper level of eyes bearing rather abundant, long, erect, plumose, yellow setae; eyes separated by a distance equal to 1.6 times the greatest width of eye (1.0 times in male *adustus*).

Pronotum 1.05 times as long as wide; widest in front of middle, the sides weakly arcuate, rather broadly rounded in front; surface longitudinally rather coarsely strigose, most punctures confluent; vestiture scanty except in marginal areas, partly scalelike at base and near anterior margin.

Elytra 1.5 times as long as wide, 1.5 times as long as pronotum; striae impressed, the punctures rather large, very close; interstriae about one and one-half times as wide as striae, surface irregular, the punctures confused, some median ones partly granulate. Declivity moderately steep, impressed between third interspaces; striae not impressed, the punctures rather large, deep; intrstriae 1 rather weakly elevated, 2 impressed, essentially flat, 3 and evidently part of lateral area forming a rather abrupt, moderately high crest, the lateral interspaces ending in this rounded summit, declining and obsolete before apex; each interspace bearing a row of small setiferous granules. Vestiture fine, almost hairlike on anterior two-thirds of disc, becoming coarse and scalelike behind; consisting of rather abundant, short interstrial setae and median rows of longer, erect setae, none as long as distance between rows.

Male.—Similar to female except frontal carina absent, upper area more strongly convex, reticulate, lower area more broadly flattened; epistomal brush somewhat reduced, yellow.

Type Locality.—Los Amendros, Paraiso (near Zamorano), Honduras.

Host.—*Acacia pennatula.*

Type Material.—The female holotype, male allotype, and 37 paratypes were collected at the type locality on April 18, 1964, at an elevation of about 700 m., by S. L. Wood, from tunnels in the central axis of branches of the above host 0.5-4.0 cm. in diameter.

The holotype, allotype, and most of the paratypes are in my collection; two paratypes are in the Schedl collection.

Cnesinus carinatus, n. sp.

Very close to *flavopilosus* Schedl, but distinguished by the more widely separated eyes, by the more coarsely strigose pronotum to base, by the much finer, essentially hairlike elytral pubescence, by the female frons being slightly inflated and pubescent in the median

area above the frontal carina, and by the male frons being much more strongly, subconcavely impressed on a much larger area.

FEMALE.—Length 2.7 mm. (paratypes 2.5-3.1 mm.), 2.7 times as long as wide; color brown.

Frons with a transverse carina at level normally occupied by occular emargination in this genus, rather weakly convex above, flattened below this point; surface above and below carina reticulate, finely punctured and pubescent; vestiture above yellow, shorter in median area, below carina reddish, erect, arranged in a transverse brush as in *flavopilosus*, not reaching epistomal margin; eyes separated by a distance equal to 2.3 times greatest width of eye. Eye entire.

Pronotum 1.09 times as long as wide; sides almost straight on basal two-thirds, very slightly wider in front of middle; surface rather coarsely, longitudinally strigose to base; vestiture confined to marginal areas.

Elytra 1.8 times as long as wide, 2.0 times as long as pronotum; sides almost straight and parallel to base of declivity, broadly rounded behind; striae impressed, the punctures small, impressed; interstriae about twice as wide as striae, convex, surface somewhat irregular, the punctures fine, confused, median row evidently subgranulate. Declivity steep, rather strongly impressed between third interspaces as in *flavopilosus;* striae 1 moderately impressed, others not impressed, the punctures reduced; interspace 1 convex, moderately elevated, 2 impressed, elevated laterally, the elevation continuing to moderately high summit on 3, each interspace with a row of fine granules. Vestiture hairlike, those on median row of each interspace longer, particularly on declivital interspace 3 and laterally.

MALE.—Similar to female except frontal carina absent; frons concavely impressed on lower two-thirds of area below upper level of eyes, entire frons pubescent, but setae longer and more abundant at sides and along epistomal brush.

TYPE LOCALITY.—Four miles west of Ciudad Hidalgo, Michoacan, Mexico.

TYPE MATERIAL.—The female holotype, male allotype, and 14 paratypes were collected at the type locality on July 16, 1953, at an elevation of 2,000 m., by S. L. Wood, from twigs of a rosaceous tree.

The holotype, allotype, and paratypes are in my collection.

Leperisinus guatemalensis, n. sp.

This species is very closely related to *californicus* Swaine and eventually may prove to be a subspecies. It is distinguished by the presence of an almost complete submarginal row of small asperities just behind the anterior margin of the pronotum, by the smaller pronotal asperities, by the smaller crenulations along the elytral bases, and by the complete absence of a median frontal carina in the female.

FEMALE.—Length 3.0 mm. (paratypes 2.4-3.1 mm.), 1.8 times as long as wide; color as in *californicus* except the light scales usually luteous.

Frons more broadly flattened to upper level of eyes, more strongly convex above eyes, and devoid of median carina, otherwise as in *californicus*.

Pronotum with an almost continuous row of small submarginal asperities connecting groups of large anterolateral asperities, and aspertities smaller, otherwise as in *californicus*.

Elytra with basal crenulations smaller, and general sculpture finer, otherwise as in *californicus*.

Male.—Similar to female except frons shallowly concave; frontal sculpture variable, but evidently epistomal emargination wider than *californicus*.

Type Locality.—Volcan Pacaya, Esquintla Prov., Guatemala.

Type Material.—The female holotype, male allotype, and 90 paratypes were collected at the type locality on June 1, 1964, at an elevation of about 1,300 m., by S. L. Wood, from cut branches of three very different host species none of which resembled *Fraxinus*. The transverse biramous egg galleries were typical of the genus.

The holotype, allotype, and paratypes are in my collection.

Chramesus incomptus, n. sp.

This species resembles other species of *Chramesus* only in the antennal club. It has a slender form, a unique sculpture of the pronotum, fine vestiture, and a sculpture of the male frons not found elsewhere in the genus. Tentatively, it is placed in the subgenus *Prochramesus* although it exhibits much more primitive characters than other species placed there.

Male.—Length 2.0 mm. (paratypes 1.9-2.1 mm.), 2.3 times as long as wide; body color brown.

Frons strongly, transversely impressed just below middle, upper area flattened to vertex, lower area strongly raised to epistoma, lateral areas rounded, unarmed; epistomal lobe conspicuous, with a pair of small tubercles at its base; surface reticulate, with small deep punctures at sides and above; vestiture fine, short, somewhat more abundant at sides and above, rather inconspicuous. Antennal club rather small, apically pointed.

Pronotum 0.9 times as long as wide; widest about one-third of pronotum length from base, the sides moderately arcuate, distinctly constricted just behind anterior margin; surface minutely granulate and with small, moderately close, shining, rounded granules; vestiture consisting of rather long, moderately abundant hair.

Elytra 1.35 times as long as wide, 1.7 times as long as pronotum; sides almost straight on basal two-thirds, very slightly wider posteriorly, broadly rounded behind; striae rather weakly impressed, the punctures rather large, deep; interstriae slightly wider than striae, weakly convex, surface irregular, the punctures rather numerous, confused, most granulate or subgranulate on anterior side; interspace 2 subcrenulate to well behind base. Declivity rather steep, broadly convex; only striae 1 weakly impressed, the punctures some-

what reduced in size; interstriae almost smooth, 3 and upper third of 1 and 2 with sparse, uniseriate, rounded granules. Vestiture moderately long, largely abraded, consisting of coarse, delicate, hairlike setae, toward declivity median interstrial rows becoming distinctly longer than similar, shorter, ground vestiture.

FEMALE.—Similar to male except frons irregularly convex with an indefinite, subfoveate, median impression, surface reticulate-granulate; epistomal tubercles present; elytral declivity more narrowly convex, the interstrial tubercles on 2 and especially 1 extending to middle or below.

TYPE LOCALITY.—Twenty-one miles west of Morelia, Michoacan, Mexico.

HOST.—*Clematis* sp.

TYPE MATERIAL.—The male holotype, female allotype, and 15 paratypes were collected at the type locality on June 16, 1965, at an elevation of about 2,200 m., by S. L. Wood, from tunnels in the cambium region of stems of the above vine larger than 1 cm. in diameter. The biramous tunnels were diagonal; usually two females were associated with each male.

The holotype, allotype, and paratypes are in my collection.

Chramesus bicolor, n. sp.

This is the only species in the genus having a sharply defined, scale, color pattern. It evidently is allied more closely to *crenatus* Wood than to other species; however, it differs by the more deeply punctured pronotum, by the larger scutellum and scutellar notch, by the deep strial punctures and by other characters.

MALE.—Length 1.5 mm. (paratypes 1.4-1.7 mm.), 1.6 times as long as wide; body color very dark brown, with white scales except dark scales on a subcordate area occupying median third of pronotum anterior to basal fourth, and on elytra a pair of dark areas on posterior half of disc from interspace to 2 to 8 but not extending on declivity.

Frons broadly excavated from vertex to epistoma, the lateral margins below eye acute, armed just below level of antennal base by a pair of small teeth; surface reticulate, punctures very fine; vestiture short, sparse.

Pronotum 0.83 times as long as wide; widest at base, the sides arcuately converging, then distinctly constricted just behind the broadly rounded anterior margin; surface rather coarsely and deeply punctured, dull; surface largely obscured by scalelike vestiture, each scale at least four times as long as wide, a few slender bristles intermixed.

Elytra 1.0 times as long as wide, 1.3 times as long as pronotum; sides straight and parallel on basal half, broadly rounded behind; striae somewhat impressed, the punctures large, rather deep; interstriae slightly wider than striae, moderately convex, the punctures squamiferous, confused, the median row subvulcanate, largely ob-

s.ured by the vestiture. Declivity steep, convex; sculpture as on disc except striae and interstriae somewhat narrower. Vestiture consisting of short, broad scales, each scale as wide as long, and median interstrial rows of erect longer scales, each about five times as long as wide and almost as long as distance between rows of scales.

Female.—Similar to male except frons weakly convex, unarmed; anterolateral areas of pronotum more coarsely asperate.

Type Locality.—La Lima, Cortez, Honduras.

Host.—*Cestrum scandens*.

Type Material.—The male holotype, female allotype, and 61 paratypes were collected at the type locality on May 5, 1964, at an elevation of about 50 m., by S. L. Wood, from stems of the above host less than 0.5 cm. in diameter.

The holotype, allotype, and paratypes are in my collection.

Chramesus vastus, n. sp.

This species differs from all others in the genus known to me by its large size, by the sculpture of the pronotum, and by the scalelike ground vestiture of the elytra with median interstrial rows of longer, hairlike setae.

Male.—Length 2.4 mm. (paratypes 2.4-2.7 mm.), 1.7 times as long as wide; color dark brown.

Frons broadly, shallowly excavated, the lateral margins acutely, rather strongly elevated and armed just below level of antennal insertion by a pair of tubercles; epistomal margin moderately, gradually elevated; surface coarsely reticulate, with fine punctures on marginal areas; vestiture inconspicuous.

Pronotum 0.8 times as long as wide; widest just behind middle, the sides strongly arcuate, moderately constricted just behind anterior margin, broadly rounded in front; surface reticulate, dull, with numerous small, isolated, shining asperities uniformly distributed from base to anterior margin; vestiture consisting of short, sparse, coarse hair.

Elytra 1.1 times as long as wide, 1.6 times as long as pronotum; sides straight and parallel on basal half, broadly rounded behind; striae 1 and 2 deeply, others moderately impressed, the punctures small, subconfluent on 1 and 2; interstriae about twice as wide as striae, weakly convex, the punctures shallow, minute, and each with a median row of large tubercles except small on base of 1 and a partial double row at base of 2. Declivity rather steep, convex; striae and interstriae narrower than on disc; the tubercles narrower and higher, except absent on lower half of interstriae 1 and 2. Vestiture consisting of very small, abundant scales, each scale slightly longer than wide except hairlike along suture, and median rows of erect, interstrial, hairlike bristles, each bristle slightly shorter than distance between rows.

Female.—Similar to male except frons convex; pronotum with punctures on disc impressed and feebly or not at all asperate toward base, lateral areas more strongly asperate than in male; elytral striae more deeply impressed, interstrial tubercles continuing to apex on 1 and 2.

Type Locality.—Cerro Punta, Chiriqui Prov., Panama.

Host.—*Inga* sp.

Type Material.—The male holotype, female allotype, and 17 paratypes were collected at the type locality on January 11-19, 1964, at an elevation of about 2,000 m., from branches of the species of *Inga* common on the hills west of Rio Viejo. The egg and larval mines were in the woody tissues.

The holotype, allotype, and paratypes are in my collection.

Chramesus demissus, n. sp.

Somewhat intermediate between *vastus* Wood (above) and *tumidulus* Blandford. It may be distinguished from *tumidulus* by the reticulate, sparsely asperate pronotum, by the much larger elytral tubercles, and by the less abundant elytral ground vestiture. From *vastus* it is distinguished by the smaller size, by the less deeply impressed, wider elytral striae, and by the very shallowly impressed male frons.

Male.—Length 2.1 mm. (paratypes 2.0-2.3 mm.), 1.7 times as long as wide; color dark brown.

Frons irregularly flattened, the lateral margins weakly elevated and armed by a pair of very small granules below level of antennal insertion; surface rather coarsely reticulate, the punctures minute; vestiture short, inconspicuous.

Pronotum 0.8 times as long as wide; widest behind middle, sides strongly arcuate, moderately constricted behind the narrowly rounded anterior margin; surface reticulate, dull, with rather numerous small, isolated asperities uniformly distributed, except median basal area, with fine, shallow punctures; vestiture consisting of sparse, slender scales.

Elytra 1.1 times as long as wide, 1.6 times as long as pronotum; sides straight and parallel on slightly more than basal half, broadly rounded behind; striae moderately impressed, the punctures rather large, deep; interstriae wider than striae, essentially smooth, the punctures very fine, each with a uniseriate row of coarse tubercles, interspace 2 with double row of tubercles at base. Declivity steep, convex; declivital granules smaller than on disc. Vestiture consisting of small scales on posterior part of disc and on declivity, each scale longer than wide; and median rows of erect, interstrial bristles, each bristle slightly shorter than distance between rows of bristles.

Female.—Similar to male except lateral margins of frons not elevated.

Type Locality.—Volcan Pacaya, Esquintla Prov., Guatemala.

TYPE MATERIAL.—The male holotype, female allotype, and 11 paratypes were collected at the type locality on June 1, 1964, at an elevation of 1,300 m., by S. L. Wood, from small twigs of an unknown tree seedling.

The holotype, allotype, and paratypes are in my collection.

Chramesus punctatus, n. sp.

This species is closely related to *demissus* Wood, described above, but is readily distinguished by the very coarse strial punctures and interstrial granules, by the longer declivital bristles on the elytra (except usually absent on interspace 2), and by the deeper frontal excavation of the male.

MALE.—Length 1.9 mm. (paratypes 1.5-2.1 mm.), 1.7 times as long as wide; color dark brown.

Frons broadly, rather deeply excavated from upper level of eyes to epistoma, the lateral margins rather strongly, acutely elevated and armed by a pair of small tubercles just below level of antennal bases; vestiture inconspicuous. Antennal scape with a small tuft of hair.

Pronotum 0.8 times as long as wide; widest on basal fourth, the sides moderately arcuate, feebly constricted just behind the narrowly rounded anterior margin; surface reticulate, dull, with numerous small, isolated, shining asperities and in posteromedian area with a few small punctures; vestiture consisting of short, semirecumbent bristles.

Elytra 1.1 times as long as wide, 1.5 times as long as pronotum; sides straight and parallel on more than basal half, broadly rounded behind; striae moderately impressed, the punctures very large, deep; interstriae about as wide as striae, convex, irregular, the punctures minute, each interspace with a row of very coarse, isolated tubercles. Declivity moderately steep, broadly convex; striae and interspaces somewhat narrower; interspaces 2 and 4 devoid of tubercles (some paratypes have one or more on each). Vestiture consisting of numerous small scales on declivity, and median interstrial rows of erect bristles from base to apex; each bristle as long as distance between rows of bristles and between adjacent bristles in a row; declivital interspaces 1 and 4 (usually) devoid of bristles (in a few paratypes both bear one or more bristles).

FEMALE.—Similar to male except frons weakly convex.

TYPE LOCALITY.—Volcan Pacaya, Esquintla, Guatemala.

HOST.—A vine, evidently *Canavalia* sp.

TYPE MATERIAL.—The male holotype, female allotype, and 90 paratypes were collected at the type locality on June 1, 1964, at an elevation of about 1,300 m., by S. L. Wood, from a vine thought to be *Canavalia* sp.; 29 additional paratypes bear similar data but were taken 14 km. west of Guatemala City, on May 30, 1964, from the same host.

The holotype, allotype, and paratypes are in my collection.

Phloeotribus simplex, n. sp.

This species is more closely related to *opimus* Wood than to other representatives of the genus known to me, but may be distinguished by its much more finely sculptured pronotum and elytra, by the reticulate surface of the pronotum, by the longer vestiture, and by other characters.

Female.—Length 1.5 mm. (paratypes 1.4-1.7 mm.), 2.1 times as long as wide; color brown.

Frons convex, with a transverse callus at level of antennal insertion; surface coarsely reticulate, with rather coarse, deep, moderately abundant punctures; vestiture inconspicuous. Antennal club with segment 1 about twice as wide as long.

Pronotum 0.9 times as long as wide; widest one-fourth from base, sides feebly arcuate on basal half, rather strongly constricted just behind broadly rounded anterior margin; surface unarmed, reticulate, the punctures small, deep, separated by distances of one to three times the diameter of a puncture; vestiture consisting of short, fine, and longer, coarse, hairlike setae.

Elytra 1.3 times as long as wide, 1.7 times as long as pronotum; basal crenulations in a single row, rather high; striae not impressed, the punctures deep, coarse; interstriae as wide as striae, almost flat and smooth with median rows of small setiferous granules. Declivity steep, convex, rather narrow; striae and interstriae narrower than on disc. Vestiture consisting of rows of fine, recumbent, strial hair, and longer, erect, uniseriate rows of interstrial bristles, each bristle somewhat flattened at its apex and spaced in the rows and between rows by distances about equal to length of a bristle.

Male.—Not represented in the series at hand.

Type Locality.—Fort Clayton, Canal Zone, Panama.

Type Material.—The female holotype and 6 paratypes were collected on December 22, 1963, at an elevation of about 30 m., by S. L. Wood, from the inner tissues of a large vine about 5 cm. in diameter. Six other paratypes were taken at Barro Colorado Island, Panama Canal Zone, on December 27, 1963, at an elevation of about 60 m., by S. L. Wood, from the same species of vine. *Scolytus nodatus* also infested this same species of vine.

Chaetophloeus minimus, n. sp.

The small size and vestiture of this species are more nearly like *Liparthrum* than other species in this genus, but the antennal and other characters clearly place it in *Chaetophloeus*. It is allied to *mexicanus* (Blackman), but may be distinguished by the smaller size, by the more slender form, by the less strongly impressed striae, by the vestiture, and by the less strongly impressed male frons.

Male.—Length 1.2 mm. (paratypes 1.1-1.4 mm.), 1.9 times as long as wide; color almost black, with white vestiture.

Frons shallowly concave from eye to eye and from epistoma to vertex; surface reticulate-granulate, vestiture consisting of moderate-

ly long, coarse hair, more abundant and longer at sides and above. Antennal club large, 1.8 times as long as wide; three sutures indicated.

Pronotum 0.6 times as long as wide; widest one-fourth of pronotum length from base, sides moderately arcuate on basal half, rather weakly constricted just behind anterior margin; surface subreticulate-granulate, with moderately large, obscure punctures; lateral area armed by one paired group of asperities; vestiture consisting of short, stout, hairlike bristles and equally abundant, erect scales, each scale as wide as long.

Elytra 1.3 times as long as wide, 2.0 times as long as pronotum; basal crenulations as in *mexicanus*, with two pair of submarginal ones on interspaces 1 and 2; striae not impressed, the punctures moderately large, deep; interstriae feebly convex, as wide as striae, the punctures fine, confused. Declivity steep, convex; striae and interstriae somewhat narrower than on disc, the interstrial punctures evidently subgranulate. Vestiture consisting of short, slender interstrial bristles along each interspatial margin, and median, interstrial rows of erect, round scales; scales separated within a row by distances equal to length of a scale, and between rows by distances equal to twice the length of a scale.

Female.—Similar to male except frons weakly convex, minutely granulate, the vestiture short, sparse; pronotum armed by two pairs of groups of asperities.

Type Locality.—Two miles east of Armeria, Colima, Mexico.

Type Material.—The male holotype, female allotype, and 15 paratypes were collected at the type locality on June 28, 1965, at an elevation of about 60 m., by S. L. Wood, from an unidentified, thornless shrub with simple leaves.

The holotype, allotype, and paratypes are in my collection.

Chaetophloeus struthanthi, n. sp.

This species is closely related to *phoradendri* Wood, but is readily distinguished by the shorter, erect, elytral scales, by the more strongly convex, granulate, female frons, by the shorter, yellow pubescence on upper part of male frons, and by the smaller, mandibular processes in both sexes.

Male.—Length 1.7 mm. (paratypes 1.6-1.9 mm.), 1.6 times as long as wide; color very dark brown.

Frons shallowly concave from eye to eye and from vertex to the broadly emarginate epistomal margin; surface with rather close, fine, subgranulate punctures; vestiture largely confined to marginal areas, longer on upper margin, but longest hairs not reaching epistoma, yellow. Antennal club 2.1 times as long as wide; sutures very obscure.

Pronotum 0.6 times as long as wide; widest one-fourth of pronotum length from base, sides very strongly arcuate on basal half,

moderately constricted just behind the broadly rounded, subemarginate, anterior margin; surface subrugulose, rather finely, closely punctured, lateral areas armed by three pairs of groups of asperities; vestiture consisting of short, erect scales, about eight much longer ones in median basal area.

Elytra 1.1 times as long as wide, 2.1 times as long as pronotum; outlines and basal asperities as in *phoradendri;* striae weakly impressed, the punctures rather small, shallowly, distinctly impressed; interspaces convex, about twice as wide as striae, the setiferous punctures small, confused. Declivity convex, steep; striae and interstriae narrower and less clearly marked than on disc. Vestiture consisting of short, semierect, small, slender scales of equal length on disc, median row on each interspace slightly longer on declivity.

Female.—Similar to male except frons convex above, flattened below, more nearly granulate; mandibular process reduced; antennal club 1.7 times as long as wide.

Type Locality.—Volcan de Colima, Jalisco, Mexico.

Host.—*Struthanthus*, probably *venetus*.

Type Material.—The male holotype, female allotype, and 86 paratypes were collected at the type locality on June 23, 1965, at an elevation of about 2,500 m., by S. L. Wood, from the above mistletoe that grew in an oak tree.

The holotype, allotype, and paratypes are in my collection.

A NEW SPECIES OF SPINIBDELLA FROM UTAH (BDELLIDAE: ACARINA)[1]

Clive D. Jorgensen[2]

Atyeo (*A revision of the mite family Bdellidae in North and Central America* [*Acarina, Prostigmata*]. Bull. Univ. Kansas 40(8): 345-499. 1960 reported *Spinibdella corticus* (Ewing) and *cronini* (Baker and Balock) from Utah in his revision of the family Bdellidae. Apparently additional records of this genus have not been reported from the state since. The following description is of a species of *Spinibdella* collected from apple tree bark at Spring Lake, Utah Co., Utah. I am grateful to Warren T. Atyeo for his examination of this species.

Spinibdella mali, n. sp.

Diagnosis.—The new species is similar to *depressa* (Ewing), but can easily be separated by the presence of two pairs of eyes. It is separated from *bifurcata* (Atyeo) by the first interspace which is more than twice as long as the length of the internal dorsals. Repeated efforts to collect additional specimens have not been successful.

Female.—Color unknown. Body striated throughout; divided by a suture into propodosoma and hysterosoma; length, including gnathosoma, 696μ. *Gnathosoma* length, 165μ; chelicera (Fig. 3) striated; length, 134μ; two strong setae; small sharp chela. Palpi (Fig. 4) short, striated; tibiotarsus extending beyond hypostome; palpal segment lengths: I, 10μ; II plus III, 111μ; IV, 16μ; V, 41μ; ventral end seta, 116μ; dorsal end seta, 152μ. Hypostome with striations transverse at proximal end, longitudinal at distal end; two pairs of strong ventral setae; length, 149μ. *Dorsal propodosoma* (Fig. 1) with infrequently broken striae; two pairs of eyes, the posterior pair being larger than the anterior. Propodosomals slightly plumose; anterior 41μ long, posterior 31μ long; distance between anterior propodosomals 75μ; distance between posterior propodosomals 46μ; distance between anterior sensillae, 39μ; distance between posterior sensillae, 95μ; striae directed forward between posterior propodosomals. *Dorsal hysterosoma* striations only occasionally broken. Setae all slightly plumose; length of external humerals, 44μ; internal humerals, 31μ; internal dorsals, 31μ; internal lumbrals, 34μ; internal sacrals, 34μ; external sacrals, 39μ; internal clunals 36μ; post anals, 36μ. Distance between external and internal humerals, 83μ; between internal humerals and internal dorsals (first interspace), 77μ; between internal dorsals and internal lumbrals, 85μ; between internal lumbrals and internal sacrals, 106μ. *Anal* border striae parallel; two

1. This study was supported in part by a grant (12-14-100-8029(33) from the U. S. Department of Agriculture to Brigham Young University.

2. Department of Zoology and Entomology, Brigham Young University, Provo, Utah.

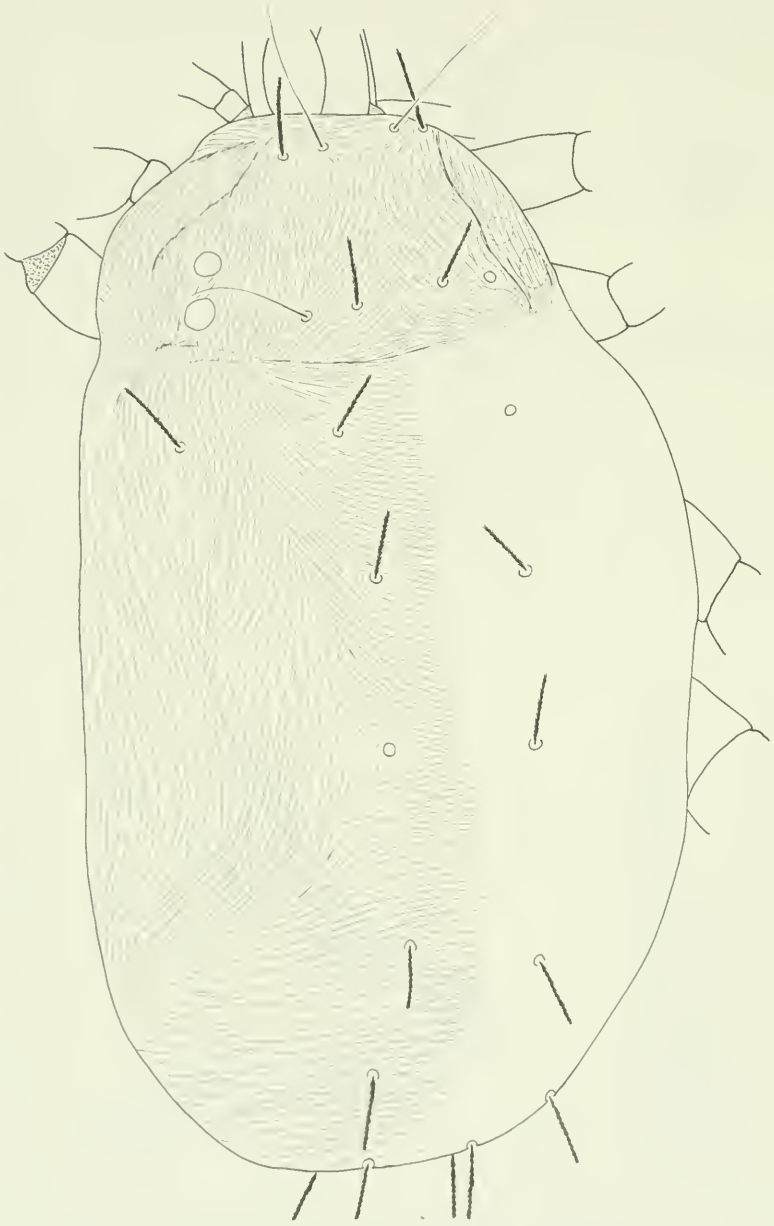
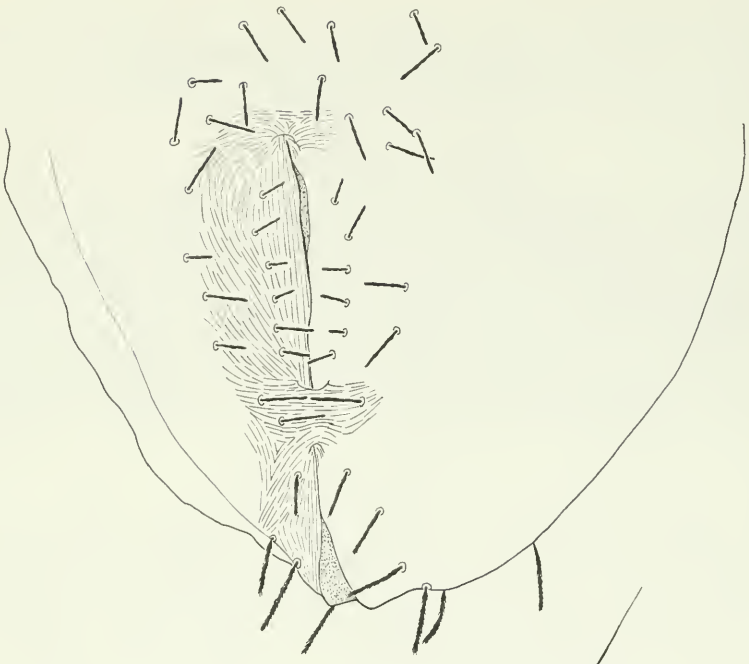
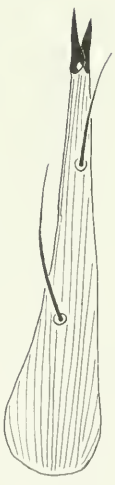


Figure 1. Dorsal view of *Spinibdella mali*.





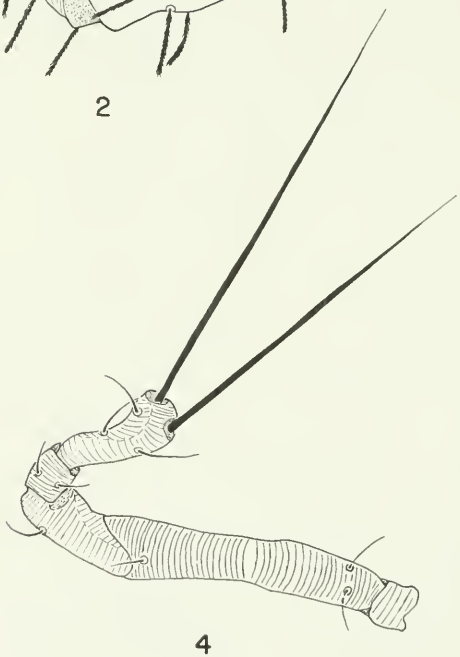


Figure 2. Genital area of *Spinibdella mali.*
Figure 3. Chelicera of *Spinibdella mali.*
Figure 4. Left palpus of *Spinibdella mali.*

pairs of anal setae, one pair of paranals; anal setae undulate but not plumose; paranals slightly plumose; anterior anals length 23μ; posterior anals length, 28μ; paranals length, 34μ. *Genital* plates (Fig. 2) with six pairs of genital setae; twelve pairs of paragenitals; setae in genital area appear brittle, several broken, always blunt and undulate. *Legs* with small strong unadorned claws, shorter than pretarsus. Measurements: tibia I-IV, 54, 59, 61, 72μ; tarsus I-IV, 75, 77, 88, 90μ. Chaetotaxy: trochanter I-IV, 1, 1, 2, 1; basifemur I-IV, 5, 5, 6, 3; telofemur I-IV, 4, 4, 4, 4; genu I-IV, 5, 5, 6, 7; tibia I-IV, 12, 11, 11, 10; tarsus II-IV, 16, 17, 16; one small blunt sensory rod of tibia II deeply recessed. Condition of specimen prevented more detailed descriptions of leg chaetotaxy.

MALE.—Unknown.

HOLOTYPE.—A single female was collected from the bark of an apple tree at Spring Lake, Utah Co., Utah, on September 28, 1965. The type specimen is deposited in the author's collection at Brigham Young University, Provo, Utah.

NOTES ON ERIOGONUM — III
ON THE STATUS OF ERIOGONUM PAUCIFLORUM PURSH

James L. Reveal [1, 2]

In 1814, Fredrick Pursh published in the appendix to his *Flora Americae Septentrionalis*, several interesting and new taxa that had been collected in North America by John Bradbury. Among the new species was *Eriogonum pauciflorum*. In the spring of 1966, for a history class, I reviewed Susan Delano McKelvey's book, *Botanical Exploration of the Trans-Mississippi West, 1790-1850*, and realized that the range of *E. pauciflorum*, as understood by the Great Plains and Rocky Mountain botanists did not get near the Missouri River, nor into North Dakota where Bradbury (1817) stated that he made his collection. To these botanists, the epithet *E. pauciflorum* referred to a plant of southeastern Wyoming and adjacent northern Colorado.

Through the kindness of Dr. A. E. Schuyler, I was able to study the holotype of *Eriogonum pauciflorum* in the Pursh Herbarium which is now deposited at the Academy of Natural Sciences in Philadelphia. The examination confirmed earlier suspicions that the name *E. pauciflorum* was misapplied. The plant that Bradbury had collected has been known for several years as *E. multiceps* Nees or *E. gnaphalodes* Benth. in Hook.

A Resume of the Discoveries

John Bradbury is a relatively unknown early botanist, although as an early writer on the area of the upper Missouri River, he is far better known. He was born near Stalybridge in Lancashire, England, in 1768, but did not come to America until 1809 when he was 41. Following the suggestions of Thomas Jefferson, Bradbury went to Saint Louis where he established his headquarters rather than at New Orleans as he had originally planned. This change was fortunate as it certainly allowed him to gather a far more interesting and unknown flora under the auspices of the Liverpool Botanic Garden (Rickett, 1950).

Unknown to Bradbury, a fellow Englishman, Thomas Nuttall, was setting out to study the western flora at the same time. Nuttall was born in 1786 in the village of Long Preston in Craven, England, and came to America ". . .in the spring of 1807 or 1808, when he was twenty-one or twenty-two. . ." (Pennell, 1936). Almost as soon

1. The author wishes to thank the United States National Herbarium and the Smithsonian Institution which sponsored his Predoctoral Internship program in Washington, D.C., from September 1966 to February 1967 where this paper was basically prepared. He is grateful to C. V. Morton and S. H. Shelter for their many helpful suggestions and assistance in obtaining critical herbarium material. The assistance of Dr. C. L. Porter of the University of Wyoming on various aspects concerning the Wyoming taxa is gratefully acknowledged. The author also wishes to thank the curators whose facilities were visited or who kindly sent loan material. This paper has been submitted to the Department of Botany, Brigham Young University, as partial fulfillment of two credits of Special Problems given during the Summer Session of 1967.

2. Department of Botany, Brigham Young University, Provo, Utah.

as Nuttall arrived, he became acquainted with Benjamin Smith Barton of Philadelphia. Nuttall, who had collected every curious plant that he saw walking into the city, had taken his unknown collection to Barton for determination. Barton's previous assistant, Fredrick Pursh, had recently left, and Barton must have been impressed by Nuttall for he soon hired the young man to collect plants for him.

In the year 1810, while Bradbury was busy collecting in the Saint Louis area, Nuttall was setting out to collect in the old "Northwest" under an exact set of directions given to him by Barton (Graustein, 1950). Nevertheless, Nuttall was soon to forget his directions.

How Nuttall and Bradbury met is not known, nor is it exactly known how the two men came to arrange to go up the Missouri River with the Overland Astorians. In a series of letters reprinted by Rickett (1950), Bradbury reveals that in late January the boat on which he had sent his 1810 collection to New Orleans had run aground below Saint Louis (in Bradbury's *Travels*, he says "autumn") and it was upon his return to the city following his investigation of the condition of the boat and his collection that he learned of the Astorians. Wilson Price Hunt, the leader of the Astorians, had been in the Saint Louis vicinity since September 1810, but to avoid the expense of over-wintering in the city, he had established a winter camp near St. Joseph, Missouri (Irving, 1836). Apparently Hunt returned to Saint Louis around the 20th of January, 1811, and no doubt it was at this time that Bradbury (no mention of Nuttall) was informed of Hunt's intention to ascend the Missouri River. On the first of March, Hunt returned to Saint Louis from his winter camp to make the necessary final arrangements for his fur trapping expedition into the Pacific Northwest (Bradbury, 1817).

The competition for the fur trade in the Oregon Country was intense between all companies engaged. The North West Company and the Hudson's Bay Company in Canada and in the Oregon Country were locked in bitter, and occasionally bloody, competition. Likewise, the Missouri Fur Company under Manuel Lisa and the American Fur Company under John Jacob Astor were rapidly becoming arch rivals. And in the middle of the American rivalry were two botanists, John Bradbury and Thomas Nuttall.

Hunt, during his trips to Saint Louis, was trying to obtain experienced men who had worked for the Missouri Fur Company in the past. At the same time, he was also attempting to purchase equipment for his trip. Manuel Lisa, the leader of the Missouri Fur Company, quickly realized that Hunt was causing a drain of men and equipment that could reflect in the fur take of his own company. One of the men that Hunt hired was Pierre Dorion, a half-breed who had been Lisa's interpreter. When Lisa found that Dorion was going to work for the Astorians, he had a warrant issued for Dorion's arrest as he had an outstanding liquor bill which had been incurred in the mountains. Bradbury and Nuttall, who had remained behind in Saint Louis for the last mail after Hunt had left, overheard the

sheriff's plans to apprehend Dorion at St. Charles. By leaving shortly after midnight on March 13th and traveling rapidly overland the two botanists, now turned spies, informed Hunt of the pending arrest, and Dorion with his wife and child fled into the woods and were not found by the sheriff. The incident involving Dorion has been interpreted in two ways. First, Irving suggests that Lisa's actions were to prevent Hunt from using the services of Dorion; Oglesby (1963), on the other hand, suggests that Lisa simply wanted to travel with Hunt and his large party in order to ward off Indian attacks.

The slow trip up the Missouri River has been discussed at some length by various writers on both expeditions (Brackenridge, 1814, with Lisa; Bradbury, 1817, with Hunt), and by various authors afterwards (Irving, 1836; Oglesby, 1963). Parts of the expeditions have been discussed in the botanical literature by Pennell (1936), Rickett (1950), McKelvey (1955), and Stevens (1946, 1959).

It is obvious from these various authors that Nuttall and Bradbury remained distant. In only four places does Bradbury even mention his fellow naturalist in his *Travels*. Although the two men were both good botanists, they had widely different outlooks on their trip and what was necessary to observe. Irving, who unfortunately has been critized as an historian, has written an excellent summary on the two men which is rather revealing:

> Mr. Nuttall seems to have been exclusively devoted to his scientific pursuits. He was a zealous botanist, and all his enthusiasm was awakened at beholding a new world, as it were, opening upon him in the boundless prairies, clad in the vernal and variegated robe of unknown flowers. Whenever the boats landed at meal times, or for any temporary purpose, he would spring on shore and set out on a hunt for new specimens. Every plant or flower of a rare or unknown species was eagerly seized as a prize. Delighted with the treasures spreading themselves out before him, he went groping and stumbling along among a wilderness of sweets, forgetful of every thing but his immediate persuit, and had often to be sought after when the boats were about to resume their course. At such times he would be found far off in the prairies, or up the course of some petty stream laden with plants of all kinds.
>
> The Canadian voyageurs, who are a class of people that know nothing out of their immediate line, and with constitutional levity make a jest of any thing they cannot understand, were extremely puzzled by this passion for collecting what they considered mere useless weeds. When they saw the worthy botanist coming back heavy laden with his specimens, and treasuring them up as carefully as a miser would his hoard, they used to make merry among themselves at his expense, regarding him as some whimiscal kind of madman.
>
> Mr. Bradbury was less exclusive in his tastes and habits, and combined the hunter and sportsman with the naturalist. He took his rifle or his fowling piece with him in his geological researches, conformed to the hardy and rugged habits of the men around him, and of course gained favor in their eyes. He had a strong relish for incident and adventure, was curious in observing the savage manners, and savage life, and ready to join any hunting or other excursion.

Thus it was that much of their collection was duplicated, but it was also this desire of Bradbury's for adventure that set him out for Fort Lisa on horseback while Nuttall, certainly much less of an

adventurer, remained behind to go up the river by boat. It was this trip that possibly allowed Bradbury to discover *Eriogonum pauciflorum*, and for Nuttall to miss it.

On the 3rd of June 1811, Lisa, who had left St. Charles on April 2nd, finally caught up with Hunt just below the Arikara Villages. From now on the small flotilla of five boats moved upstream, but with Hunt always in the front so that Lisa could not pass him. The parties finally arrived at the Villages, which were located near present-day Wakpala, Corson County, South Dakota, on the west bank of the Missouri River some six miles above the mouth of the Grand River.

On the 19th of June, Hunt and Lisa settled some of their differences, and a trade of Hunt's boats for some of Lisa's horses had been arranged. It was decided that a party should be sent overland for the horses which were at the Missouri Fur Company's fort several miles upstream. When Bradbury learned of the pending trip, he ". . . declared to Mr. Hunt that, unless he absolutely refused me the privilege, I was determined to accompany them." Hunt gave his consent, and mounted on a bare wooden saddle on a poor horse, Bradbury set off, often collecting plants and putting them under his hat until he had a moment to dismount and press them. On the evening of the 22nd, the party reached the fort.

There has been considerable confusion in the botanical literature as to the locations of the forts and Indian villages on the upper Missouri River, and to some degree, this is due to a similar confusion in the historical literature on this period. While I certainly do not wish to proclaim to have the final word on this subject, some new and hopefully enlightening information can be presented.

In attempting to determine the exact localities mentioned by Bradbury, I wrote the State Historical Society of North Dakota[3] at the suggestion of Dr. LeRoy R. Hafen, Professor of Far Western History, Brigham Young University. The information that was obtained from Sperry contradicts, to some degree, with the traditional data given as to the location of the forts and Indian villages, and this is presented here in some detail so that a clearer picture of their locations might be understood.

In 1804, Lewis & Clark built Fort Mandan where they overwintered in 1804-1805. Nevertheless, in 1811 this site was abandoned, for Lewis & Clark reported (1814) that when they returned in August 1806, they found that a large portion of the fort had been burned. Sperry believes that the site was probably still obvious when Bradbury visited the area. When Alexander Philip Maximilian, a Prussian soldier and scholar, later visited the area in the winter of 1883-1834 at Fort Clark, he mentioned (1841) that the river had changed its course and that the site of Fort Mandan was either on the opposite bank (the east bank) or in the middle of

3. In response to my letter, Mr. James E. Sperry, Research Archeologist, wrote on 19 January 1967 his reply which is the major basis for the discussion on the locations of the forts and Indian villages. His letter is deposited in my personal correspondence and in that of C. V. Morton's, Smithsonian Institution, Washington, D.C.

the river. Sperry comments that the exact site of Fort Mandan has not been discovered, but according to the maps of Lewis & Clark and of Maximilian, he believes that the fort was on the east bank of the river and about 1 5 miles northeast of the site of Fort Clark in present-day McLean County, North Dakota.

Sperry says that the site of Fort Lisa, which was later named Fort Vanderbaugh, also has not been definitely located. Bradbury (1817) indicated that after crossing the Knife River, they had ". . . seven miles still to travel in order to reach the Fort. . ." If his distances are correct, that would put the site of the fort just over a mile south of Mannhaven on the west bank of the Missouri River in Mercer County.

In the story of *Eriogonum pauciflorum*, the locations of the Indian villages are also important. Sperry writes that in 1811 there were only two Minetaree Villages, both of which are still quite evident. These villages were simply called the upper and lower villages by Bradbury. The lower village was a small site about one mile north of the town of Stanton on the south side of the Knife River near the present-day Stanton Cemetery. The upper village, which was considerably larger, was located about 2.8 miles north of Stanton, or on the north side of the Knife River near the present site of the Olds School. Thus, the type area of *E. pauciflorum* appears to be north of Stanton, Mercer County, rather than south of Mannhaven (or the location of Fort Lisa) as was stated by Stevens (1946).

From Bradbury's journal, it is apparent that he was in the vicinity of the Minetaree Villages on three different days of June: the 22nd when he rode through in the late evening; the 24th, at which time he collected on the bluffs north of the upper village; and the 28th when he was actually in and around the Minetaree Villages. While Bradbury might have been able to collect the *Eriogonum* on the 22nd, it seems unlikely as it was late in the evening and he knew that he was going to be in the area for a few days. The bluffs north of the upper village which he visited on the 24th are an excellent place for the *Eriogonum* to grow. However, Bradbury specifically stated that the *Eriogonum* came from near the Minetaree village, and it is assumed that the buckwheat was not collected on this date. Therefore, it would seem most likely that Bradbury collected the type of *E. pauciflorum* on the east facing slopes of the low hills northwest of the upper village when he visited it on the 28th of June 1811.

The discovery of *Eriogonum multiceps* by Alexander Philip Maximilian, Prince of Wied-Neuwied, can be traced with a little more exactness. The holotype deposited at Jardin Botanique de l'État, Bruxelles, Belgium, consists of two specimens, one simply says "Am uberen Missouri" while the other gives the same information, a collection number (#114), and a date, "6 July." On July 6th, Maximilian was at Fort Union, a post near the North Dakota-Montana state line, where he had been since the 24th of June 1833.

However, on the 6th, he reported that he was preparing to leave for Fort McKenzie further up the river, and probably the collection was not actually made on this day, but on a day before while still at Fort Union as he does mention collecting plants there. It seems likely from comparing recent specimens that have been collected in this area, that the Maximilian collection could have come from the Fort Union area, although in his book (1841), no mention of an *Eriogonum* is made.

The entire collection of some two hundred plants was turned over to Nees von Esenbeck of Poland, who prepared the botanical appendix which appears in Maximilian's book. When Nees described *Eriogonum multiceps*, he compared it with *E. pauciflorum*, and unlike Pursh, adequately described the species. Unfortunately, the publication *Reise in das innere Nord-America in den Jahren 1832 bis 1834*, was not seen by the American botanists until the middle of the century, and the name *E. multiceps* was not noted in print until Torrey & Gray's 1870 revision of Eriogoneae.

In the meanwhile, Bentham had named *Eriogonum gnaphalodes* which had been collected by Carl Andreas Geyer, a German collector, probably in the Guernsey area, Platte County, Wyoming, which is near Fort Laramie (Goshen County) which is the location given by Geyer (1845-1846) for this plant. When Torrey & Gray discovered that *E. gnaphalodes* and *E. multiceps* were basically the same kind of plant, they placed the Bentham name into synonymy, and their concept of *E. multiceps* for the Great Plains species has been followed since.

Key to the Species

A. Perianth pubescent externally; leaves grayish or whitish tomentose on both surfaces, sheathing up the stems; common in eastern Wyoming and adjacent Nebraska northward to extreme southern Canada.

1. *E. pauciflorum*

AA. Perianth glabrous externally; leaves densely tomentose below, subglabrous or glabrous above; southeastern Wyoming and Colorado.

B. Leaves linear to linear-oblanceolate, less than 3 mm wide, tightly revolute; involucres usually glabrous externally; gumbo clay to granitic soils, mostly below 8,500 feet; Grand Co., Colorado northward to Albany and Larimer cos., Wyoming.

2. *E. exilifolium*

BB. leaves oblanceolate to lanceolate or narrowly elliptic, 3-6 mm wide, not revolute; involucres usually tomentose externally; granitic talus or gravelly slopes and flats from 8,500 to 12,500 feet; El Paso Co. westward to Gunnison Co., Colorado.

3. *E. coloradense*

1. *Eriogonum pauciflorum* Pursh, Fl. Am. Sept. 2: 735. 1814.

Low spreading leafy-stemmed perennial herbs which form loose mats up to 2 dm across; leaves linear-oblanceolate to oblanceolate, 3-5 (8) cm long, (1) 2-6 mm wide, grayish to whitish tomentose below, less so to subglabrous and green above, sheathing up the stems 1-5 cm, tapering gradually to petioles (0.5) 1-2.5 cm long, the petiole-bases appressed and clasping, 1.5-3 mm wide; flowering stems 5-15 (20) cm long, tomentose; inflorescences single capitate cluster of several involucres or umbellate with rays simple and up to 5 cm long, the involucres or the first node subtended by a whorl of 2-6 linear to semifoliaceous lanceolate bracts, 1.5-20 mm long, the inflorescence head ca 1 cm broad; involucres narrowly turbinate, (3.5) 4-5 mm long, tomentose, the 5 acute teeth 0.5-0.8 mm long, triangular; perianth whitish-brown, cream, pink, or rose-tinged, usually densely pubescent on the lower half or rarely glabrous, 2-2.5 mm long, the calyx-segments similar, oblong, connate about ¼ to ⅓ the length of the perianth, the bases rounded or slightly acute, the apices rounded; stamens 2.5-3 mm long, the filaments pilose at the bases, the anthers 0.3-0.4 mm long, oblong; achenes brownish, 2 mm long, the globose to subglobose bases tapering to scabrous 3-angled beaks.

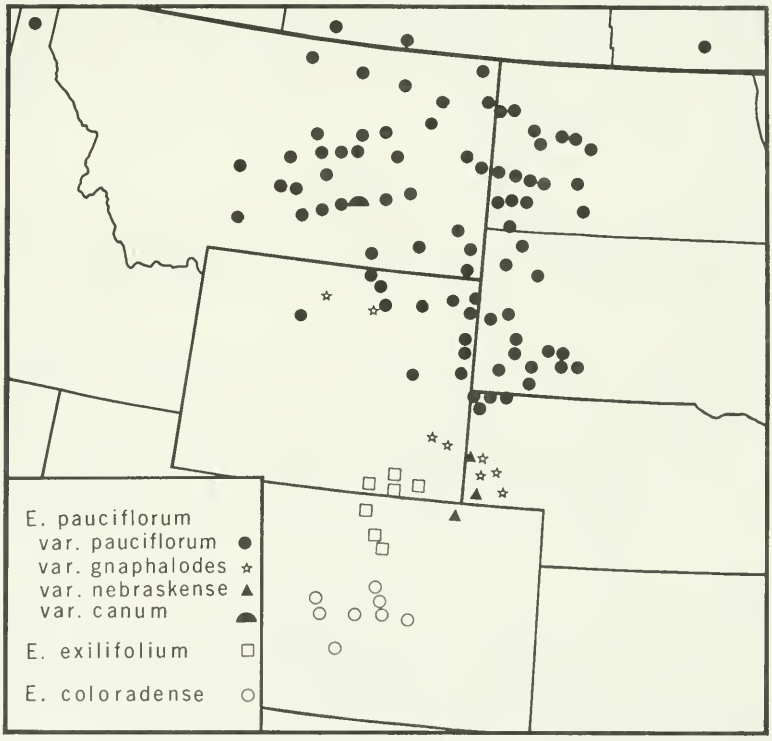


Figure 1. Distribution of *Eriogonum pauciflorum* Pursh.

KEY TO VARIETIES

A. Inflorescences capitate or nearly so, rays not compoundly divided nor subtended by bracts.
  B. Leaves tomentose below, somewhat less tomentose above, linear-oblanceolate to oblanceolate, mostly 3-5 (8) cm long and up to 6 mm wide, not densely pubescent with long white, densely tangled and matted hairs; inflorescences ca 1 cm broad; south-central Canada south to eastern Wyoming.
    1a. var. *pauciflorum*
  BB. Leaves densely matted with long white tangled hairs on both surfaces of the leaves, the leaves narrowly spathulate, mostly 2-3.5 cm long and up to 10 mm wide; inflorescences ca 1-1.5 cm broad; eastern Wyoming and adjacent western Nebraska.
    1b. var. *gnaphalodes*

AA. Inflorescences compoundly branched, cymose.
  B. Flowers white; extreme western Nebraska and adjacent northeastern Colorado.
    1c. var. *nebraskense*
  BB. Flowers yellow; central Montana.
    1d. var. *canum*

1a. *Eriogonum pauciflorum* var. *pauciflorum*

E. parviflorum Nutt.. Journ. Phil. Acad. 1: 35. 1817, a superfluous substitute for *E. pauciflorum* Pursh.

E. dioecium Raf., Herb. Raf. 38. 1833, *nom. nud.*; New Fl. N. Amer. 4: 53. 1838. TYPE: On River Platte." *Bradbury s.n.* See comments below.

E. multiceps Nees in Wied-Neuwied, Reise Nord-Amer. 2: 446. 1841. TYPE: Fort Union, Williams Co., North Dakota, 6 Jul 1833, *Prince Alexander Philip Maximilian* 114. Holotype: BR!

E. depauperatum Small, Bull. Torrey Bot. Club 25: 40. 1892. TYPE: Hermosa, Custer Co., South Dakota, 23 Jun 1892, *Rydberg* 970. HOLOTYPES NY! Isotypes: NEB! US; A form with glabrous flowers.

E. multiceps ssp. *typicum S. Stokes*, Gen. Eriog. 94. 1936.

Low spreading leafy-stemmed, loosely matted, perennial herbs; leaves linear-oblanceolate to oblanceolate, leaf-blades 1-4 cm long, (1) 2-6 mm wide, grayish to whitish tomentose below, less so to subglabrous and green above, gradually tapering to petioles 2-5 cm long; flowering stems 5-20 cm long; inflorescences loosely capitate and ca 1 cm broad or umbellate with simple rays up to 5 cm long.

TYPE: NORTH DAKOTA: Mercer Co.: About 2.8 mi n of Stanton, possibly on the east facing slopes northwest of the present site of

the Olds School, on the north bank of the Knife River, elevation about 1800 feet. 28 Jun 1811. *Bradbury s.n.* Holotype: PH! Isotype: GH!

Representative Specimens: CANADA: MANITOBA: La Riviere *Dawson s.n.* (GH, K, MO, UC, US). SASKATCHEWAN: Bracken, *Campbell* 38 (MONTU); Wood Mts., *Macoun* 12949 (NY). UNITED STATES: IDAHO; Bonner Co.: Kootenai, 1887, *Sandberg et al.* 997 (CAS, NY). MONTANA: Big Horn Co.: 23 mi n of Grassland, *Anderson & Wright s.n.* (MONT). Blaine Co.: 9 mi e of Zurich, *Booth* 57568 (MONT). Carter Co.: 2 mi s of Alzada, *Booth* 2664 (MONT); Box Elder Cr., *Rose* 395 (MONTU). Custer Co.: 9 mi w of Miles City, *Hanna* 2559 (MONT). Dawson Co.: Glendive, 1900, *Blankenship s.n.* (MONT, MONTU), 1903, *Blankinship s.n.* (MONTU, RM, UTC); Colgate, 1892, *Sandberg et al.* 997 (CAS, DS, GH, MO, NY, RM, UC, US). Fergus Co.: Big Snowy Mts., *Canby s.n.* (MO, NY, PH, US); 30 mi ne of Roy *Mackie s.n.* (MONT). Garfield Co.: Squaw Cr., *Holmgren* 2076 (MONT, NY, UTC); 30 mi e of Jordan, *Ripley & Barneby* 8243 (NY). Golden Valley Co.: 2 mi nw of Levina, *Booth* 55205 (MONT). McCone Co.: 20 mi w of Circle, *Booth* 57220 (MONT). Meagher Co.: 28 mi w of Harlowton, *Booth s.n.* (RM). Musselshell Co.: 10 mi nw of Roundup, *Booth s.n.* (MONT). Park Co.: White Beaver Cr., *Tweedy s.n.* (NY). Petroleum Co.: Mosby, *Booth* 57205 (MONT); 10 mi sw of Winnett, *Cole s.n.* (MONT); 15 mi ne of Grass Range, *Kirsch s.n.* (MONT). Phillips Co.: 14 mi sw of Malta, *Atwater s.n.* (MONT). Powder River Co.: 13 mi nw of Broadus, *McVaugh* 6465 (GH, UC). Roosevelt Co.: Culbertson, *Coey* 50 (NEB). Rosebud Co.: Forsyth, *DeCock s.n.* (MONT). Sheridan Co.: 1 mi ne of Plentywood, *Booth s.n.* (MONT). Valley Co.: Glasgow, *Booth* 57622 (MONT). Wheatland Co.: 3 mi nw of Shawmut, *Booth* 55305 (MONT). Yellowstone Co.: Billings, 1902, *Blankinship s.n.* (MONTU, RM), 1903, *Blankinship s.n.* (RM, UTC); Pompey's Pillar Butte, *Wright* 80 (MONT). NEBRASKA: Dawes Co.: 10 mi n of Crawford, *Tolstead* 952 (GH, NEB). Sioux Co.: Harrison, *Bates s.n.* (GH); Orella, *Pool & Folsom s.n.* (NEB); Hat Cr. Basin, *Webber s.n.* (CAS, NEB, US). NORTH DAKOTA: Billings Co.: Mendora, *Larsen* 184 (GH, MO). Bowman Co.: Rhame, *Stevens s.n.* (MONT, NDA, RM, US). Dunn Co.: Killdeer Mts., *Stevens & Moir s.n.* (NDA). Golden Valley Co.: Sentinel Butte, *Stevens* 2583, 2584 (NDA, UC). Grant Co.: sw of Shields, *Bell* 203, 1259 (NDA). McLean Co.: Elbowoods, *Heidenreich s.n.* (NDA, UC). Mercer Co.: near Mannhaven, *Stevens* 908 (NDA, UC). McKenzie Co.: North Roosevelt Park, *Stevens s.n.* (NDA); s of Williston, *Waldron* 2360 (NDA). Morton Co.: 6 mi e of Glen Ullin, *Rollins & Muñoz* 2813 (GH, US, UTC). Slope Co.: Marmarth, *Brenckle & Stevens* 39-377 (NDA). Stark Co.: Belfield, *Bergman s.n.* (NDA); Dickinson, *Stevens* 1503 (NDA, UC, US). Williams Co.: Fort Union, *Hayden s.n.* (GH, MO, NY). SOUTH DAKOTA: Fall River Co.: 18 mi w of Edgemont, *Porter* 6706 (RM); Hot Springs, *Rydberg* 971 (NEB, NY, US). Harding Co.: 4 mi s of Redig, *Jones* 36607 (COLO); Moreau, *Visher* 130 (RM). Hyde Co.: Peno Hills, *Williams s.n.* (US). Jackson Co.: Interior, *Brenckle* 40-43 (UTC); Cedar Pass, *Palmer* 37653 (A, MO, US). Lawrence Co.: Lawrence County, *Over* 13783 (US). Meade Co.: Fort Meade, *Forwood* 322 (US). Mellette Co.: Mellette County, *Over* 15920 (RM, US). Pennington Co.: 1 mi e of Wall, *McIntoch* 1389 (NY); se of Rapid City, *Over* 15921 (RM, US). Perkins Co.: Badlands, *Goodman* 3291 (GH, NY, UC), *Hapeman s.n.* (NY, UC, UTC). Shannon Co.: White River Valley, *Visher* 2183 (NY). Washabaugh Co.: Bear Cr., *Over* 2326 (COLO). WYOMING: Campbell Co.: 10 mi nw of Gillette, *Pennell* 21376 (PH, RM). Converse Co.: near Bill, *Ownbey & Lang* 1055 (RM). Crook Co.: Rockyford, *A. Nelson* 2215 (GH, MO, NY, RM, US); Sundance, *A. Nelson* 9600 (DS, GH, RM, US); 10 mi n of Devil's Tower, *Seig* 19 (RM). Johnson Co.: 10-12 mi n of Buffalo, *Pennell & Schaeffer* 24416 (PH). Niobrara

Co.: Lusk, *Osterhout* 7862 (RM); Cheyenne River, *T. A. Williams s.n.* (RM). Park Co.: Sage Cr., *T. A. Williams s.n.* (NY, RM). Sheridan Co.: Ucross, *A. Nelson* 9740 (MO, RM, UC); e of Sheridan, *Rollins* 559 (GH, NY). Weston Co.: Newcastle, *A. Nelson* 8429 (DS, GH, MO, NEB). NY, RM, US); 10 mi s of Newcastle, *Porter* 3401 (GH, RM, UC, US).

Eriogonum pauciflorum is a member of the section *Capitata* Torr. & Gray of the subgenus *Eucycla* (Nutt.) Kuntze in Post & Kuntze, and will be selected as the type of the section in a forthcoming paper on the subgenera of *Eriogonum* (Reveal, in press). The variation in *E. pauciflorum* is excessive, and the exact nature of the overall variation is still not entirely surveyed. Within var. *pauciflorum*, the degree of tomentum on the leaves is variable, but never is it as dense as in var. *gnaphalodes*. Although in the vicinity of Newcastle, Weston Co., Wyoming, the upper leaf surfaces are often totally glabrous, throughout most of the range of this taxon, the leaves are subglabrous to sparsely tomentose above. The inflorescence of var. *pauciflorum* varies from a fairly tight capitate cluster of involucres to one in which the peduncles have elongated and form umbellate heads. This latter condition is scattered throughout the range of the variety, and does not seem to be of any taxonomic significance. The species, *E. depauperatum* Small, was based on a form of var. *pauciflorum* with glabrous flowers. However, as nearby populations have pubescent flowers, and as this is the only differential character, it seems best not to recognize it as a distinct taxon.

In 1838, Rafinesque published *Eriogonum dioecium*. The only *Eriogonum* specimen of the Bradbury collection, which was cited as the type, that could fit the species description is the type collection of *E. pauciflorum*. H. W. Rickett of the New York Botanical Garden (1950; per. comm.) has indicated that possibly some of the Bradbury specimens were distributed by William Roscoe of Liverpool who Bradbury had originally sent his collection, and that some duplicates may have come into the possession of Rafinesque. Rafinesque states that as early as 1833 he had obtained some Bradbury specimens, although he made no reference as from whom he had received them. Rickett indicated that the Pursh collection which was originally part of the Lambert Herbarium in England, was not sold until 1842, and as this collection did not come to Philadelphia until some years after that, it seems impossible that Rafinesque could have seen the holotype of *E. pauciflorum*. He might have seen another duplicate, but this I have been unable to locate. The Rafinesque collection was sold after his death to Elias M. Durand, then the botanist of the Academy of Natural Sciences in Philadelphia, but whether or not Durand discarded the collection as he did with so much of the Rafinesque collection, or kept it and is now deposited in Durand's personal collection which he gave to the Museum National d'Historie Naturelle in Paris, France, has not been determined. The name, *E. dioecium*, is therefore questionably referred to *E. pauciflorum* until the type can be seen.

The one problem in referring *Eriogonum dioecium* to *E. pauciflorum* is the supposed location of the collection site given by Rafinesque. Bradbury collected only two *Eriogonum* species, and the only two known to grow in the area, *E. flavum* Nutt. in Fras. and *E. pauciflorum*. Both came from near the Minetaree Villages. Rafinesque gave the location of his specimen as coming from the Platte River, but as Bradbury usually only gave the location as the "Upper Louisiana" on his specimens, it may have been that Rafinesque was simply guessing a more exact locality in order to be more specific.

The transfer of the concept of the name *Eriogonum pauciflorum* away from the type to that of a plant in Wyoming and Colorado may have been due to John Torrey's misidentification of an Engelmann collection of Albany Co., Wyoming, that was made in 1856, and a Parry collection from Middle Park, Colorado made a few years later. When Pursh described the Bradbury collection, he did not indicate that the flowers were pubescent, and as the collection was of a series of immature specimens, it is possible that Pursh never knew of this condition. Pursh must have hoarded nearly the entire collection as according to Rickett (1950), there are no specimens in European herbaria, and the only collection in the United States was deposited in the Pursh Herbarium in Philadelphia. Later, a single plant specimen was cut from the Philadelphia sheet and sent to Asa Gray at Harvard University by Durand in 1866. It was on this specimen in the Gray Herbarium that Torrey wrote that the Bradbury, Engelmann, and the Parry collections were all the same, and thus the concept of *E. pauciflorum* was transferred. This interpretation which appeared in the Torrey & Gray 1870 revision has been followed since.

1b. *Eriogonum pauciflorum* var. *gnaphalodes* (Benth. in Hook.) Reveal, stat. & comb. nov.

E. gnaphalodes Benth. in Hook., Journ. Bot. & Kew Misc. 5: 263. 1853.

Low-spreading leafy-stemmed, densely matted, perennial herbs; leaves narrowly spathulate to elliptic, the leaf-blades 1-2.5 cm long, 4-10 mm wide, densely white-tomentose on both surfaces with long tangled and matted hairs, the leaf-blades usually abruptly tapering to petioles 1-3 cm long; flowering stems 3-10 (15) cm long; inforescences densely capitate, mostly 1-1.5 cm broad.

Type: WYOMING: Platte Co.: near Guernsey on cliffs which are west of the type locality of Fort Laramie, Goshen Co., which was cited by the collector, Jul 1843, *Geyer* 150. Holotype: K! Isotype: K!

Representative Specimens: NEBRASKA: Without definite locality: Between Pole Cr. and Cedar Bluffs, *Engelmann s.n.* (GH, MO, NY). Cheyenne Co.: Bayardito, *Baker s.n.* (MO); Courthouse Rock, *Rydberg* 334 (NY, US). Morrill Co.: Chimney Rock, *Hapeman s.n.* (CAS, MO, NY, RM, UC). Scotts Bluff Co.: Scotts Bluff, *Rydberg* 334 (NY); WYOMING: Converse Co.: Bed Tick Cr., *E. Nelson* 5040 (MONT, RM).

Big Horn Co.: Trapper Basin, *Finley* 31 (RM); Clark, *Pearson* 224 (RM). Johnson Co.: Buffalo, *Tweedy* 3265 (NY, RM). Platte Co.: Lake Guernsey State Park, *Porter* 3989 (DS, RM), *Porter* 4317 (GH, RM, UC, US). Washakie Co.: Spring Cr., s of Ten Sleep, *Gooding* 354 (DS, GH, NEB, NY, RM, UC, US).

The var. *gnaphalodes* may be distinguished by its greater reduction and compaction of the mat, and by its leaves which are wider and more densely tomentose than in var. *pauciflorum*. The inflorescence is correspondingly more compacted and the involucres are always tightly held together and not at all umbellate as in var. *pauciflorum*. As the var. *gnaphalodes* tends to occur on the western and southern edge of the distribution of the species, and is rather distinctive in the field it is now recognized as a variety.

The placement of *Eriogonum gnaphalodes* under *E. multiceps* by Torrey & Gray (1870) must have come without a chance to see the type of *E. multiceps*, or additional material from the upper Missouri River basin where the type of *E. multiceps* was collected. As the Geyer collection and the Maximilian collection are similar in several general features, Torrey & Gray must have been working only with the description of *E. multiceps* which compares somewhat favorably with the type of *E. gnaphalodes* which Gray had seen in the Bentham collection in England.

1c. *Eriogonum pauciflorum* var. *nebraskense* (Rydb.) Reveal, stat. & comb. nov.

E. nebraskense Rydb., Fl. Rocky Mts. 224, 1061. 1917.

Low spreading, leafy-stemmed, perennial herbs, 2-3 dm high; leaves oblanceolate, the leaf-blades 1.5-3.5 cm long, 3-5 mm wide, densely white-tomentose below, grayish-tomentose above, gradually tapering to short petioles 0.5-1.5 (2) cm long; flowering stems 1-2 dm long; inflorescences compoundly branched, cymose; perianth rose to dark red or brown.

Type: NEBRASKA: Kimball Co.: prairies in Kimball County, 12 Aug 1891, *Rydberg* 337. Holotype: NY! Isotype: US!

Representative Specimens: COLORADO: Hugo Co.: Pawnee Buttes, *Johnston* 111 (RM). Weld Co.: Keota, *Osterhout* 5928 (RM, UC), *Osterhout* 6037 (RM). NEBRASKA: Scotts Bluff Co.: Scotts Bluff County, *Winter* 93 (NEB).

The var. *nebraskense* is a narrowly restricted population that is readily distinguished from the rest of the section *Capitata* by its compound cymose inflorescence.

The reduction of *Eriogonum nebraskense* to a variety under *E. pauciflorum* comes somewhat as a reluctant move. The only distinguishing characteristic that separates the umbellate forms of var. *pauciflorum* from var. *nebraskense* is the compound cymose inflorescence. However, in reviewing the associated species in the area where var. *nebraskense* occurs in part, it is possible that var. *nebras-*

kense may represent a population that has been genetically influenced by *E. effusum* Nutt. so that the distinct inflorescence was introduced. Until detailed field work can be carried out, I am following what the gross morphology dictates, and that is to treat *E. nebraskense* as a variety of *E. pauciflorum*.

1d. *Eriogonum pauciflorum* var. *canum* (S. Stokes) Reveal, stat. & comb. nov.

E. multiceps Nees ssp. *canum* S. Stokes, Gen. Eriog. 94. 1936.

Low spreading, leafy-stemmed, perennial herbs, 1.5-2.5 dm high; leaves narrowly oblanceolate to lanceolate, the leaf-blades 1.5-3 cm long, 2-4 mm wide, densely white-tomentose on both surfaces, gradually tapering to short petioles 0.5-1.5 cm long; flowering stems up to 1 dm long; inflorescences compoundly branched, cymose; perianth yellow.

Type: MONTANA: Treasure Co.: Custer, 6 Jul 1890, *Blankinship* 113. Holotype: UC! Isotype: US! Stokes cites the date as 30 Jun 1890, but as no sheet at UC with this date has been found, it is assumed that she made an error in citing the date of the collection.

Representative Specimens: MONTANA: Without definite location: Montana, 1873, *Allen s.n.* (US). Treasure Co.: Custer, *Brenckle & Stevens* 39-371 (A, GH, NDA).

The var. *canum* differs from var. *nebraskense* in its yellow flowers and distinct distribution.

Like var. *nebraskense*, the var. *canum* tends to suggest the effects of possible hybridization, but this time with *Eriogonum brevicaule* Nutt. However, as *E. brevicaule* is not known to be from this area, considerable field work is necessary on this taxon, and the present taxonomic arrangement merely reflects the morphological relationships.

2. *Eriogonum exilifolium Reveal*, spec. nov.

E. pauciflorum of authors, not Pursh.

A *Eriogonum coloradense* Small foliis linearibus vel linearioblanceolatis, revolutis, inflorescentiis pro parte maxinis compactis cymosis, bracteis membranaceis in scapis 3-10 cm longis, involucris saepe glabris, perianthiis 2-3.5 mm longis differt.

Planta pulvinata perennis; caules basi per 1.5 cm foliosi; laminae foliorum lineares vel lineari-oblanceolatae, revolutae, (2) 3-5 (6) cm longae, 1-2 (3) mm latae, subtus dense albo-tomentosae, supra subglabrae vel glabrae, petiolis brevibus, 5-15 mm longis, basi membrancea, 5-10 mm longa et 3-5 mm lata, glabris vel pubescentibus; scapi 3-10 cm longi, glabri vel tomentosi; inflorescentiae cymosae subcapitatae, brevibus radiis 1-4 mm longis, vel capitatae involucris 3-6 dense compactis, bracteis ternatis, semifoliaceis, membranaceis, glabris vel parce tomentosis, 3-5 mm longis, 2-3 latis; involucra

campanulata, 2.5-3.5 (4.5) mm longa, 2-3 mm lata, 5-lobata; perianthia alba vel rosea, 2-3.5 mm longa, segmentis similibus, ellipticis; stamina 2-2.5 mm longa, filamentis basi pilosis, antheris 0.3 mm longis, oblongis; achaenia brunnea, 2-3.5 mm longa, ovata.[4]

Perennial herbs with strong taproots and branched woody underground caudices up to 8 cm long, forming densely pulvinate mats up to 2 dm across, sparsely tomentose to glabrous througout; leaves numerous, linear to linear-oblanceolate, tightly revolute, (2) 3-5 (6) cm long, 1-2 (3) mm wide, densely white-tomentose below, less so to glabrous and green above, basal or sheathing up the stems 1.5 cm, the apices acute, the bases long-cuneate, gradually tapering to short petioles 5-10 mm long, the petiole-bases membranaceous, light brown to tan, expanded and elongated, 5-10 mm long, 3-5 mm wide, glabrous without, pubescent with long dense white hairs within and along the margins; scapes 3-10 cm long, glabrous or sparsely tomentose, ± wirey; inflorescences compact cymose-umbels of 3-7 subcapitate involucres with the short stout rays 1-4 mm long, the inflorescences subtended by 3 semifoliaceous membranaceous, glabrous or sparsely pubescent at the bases and within, triangular bracts, 3-5 mm long, 2-3 mm wide at the bases, connate; involucres campanulate, 2.5-3.5 (4.5) mm long, 2-3 mm wide, glabrous without except for small patches of cottony tomentum at the base of the lobes in some, 5-lobed, the lobes 1-1.5 mm long, rounded, truncate or triangular, distinctly margined with thin membranaceous margins, erect or more often spreading and reflexed; perianth white to rose, 2-3.5 mm long, glabrous within and without except for a few scattered hairs on the lower half within on some, the segments nearly equal, oblanceolate to elliptic, connate ¼ to ⅓ the length of the perianth, the perianth tubes dark red to brown, occasionally angled; stamens exserted, 3-4 mm long, the filaments pilose at the bases, anthers 0.3 mm long, oblong; achenes brown, 2-3.5 mm long, ovate, the globose bases tapering to 3-angled beaks.

Type: WYOMING: Albany Co.: 2 mi n of Laramie, 21 Jul 1945, *C. L. Porter* 3706. Holotype: RM! Isotypes: DS, GH, MO, NY, UC, US.

Representative Specimens: COLORADO: Grant Co.: Middle Park, *Parry s.n.* (GH, NEB, NY, US); nw of Tabernash, *Ripley & Barneby* 10489*a* (CAS, NY). Jackson Co.: North Park, *Crandall* 133 (GH, MO, NY); Lake John, *Ramaley & Johnson* 890 (CAS, COLO, MO). WYOMING: Albany Co.: From Laramie River along the Medicine Bow Mts., *Engelmann s.n.* (GH, MO, NY); Red Buttes, *Greene s.n.* (NY); Laramie Plains, *A. Nelson* 2794 (GH, MONT, NY, RM, US); Laramie, *A. Nelson* 7637 (COLO, GH, NEB, NDA, NY); Laramie River, *E. Nelson* 3385 (BM, MO, NY, RM, US). Larimer Co.: North Fork, *Goodding* 1924 (COLO, NY, UC, US).

This taxon has long been recognized as an excellent species, and the naming of it as such after so many years is simply due to the misapplication of the name *Eriogonum pauciflorum* for it. The new species is closely related to *E. coloradense* from which it differs

[4]The author is grateful to C. V. Morton for his assistance with the Latin description.

mainly in its leaf-shape and general size of its parts. The distinct ecological requirements also differ. The plants in Wyoming are found mainly on hard gumbo clay hills, but in Colorado, they are often found on rolling granitic sand hills below 8,500 feet elevation.

The species name is selected to denote the narrow leaves.

3. *Eriogonum coloradense* Small, Bull. Torrey Bot. Club 33: 53. 1906.

E. multiceps Nees ssp. *coloradense* S. Stokes, Gen. Eriog. 94. 1936.

Perennial herbs with strong taproots and branched woody underground caudices up to 4 cm long, forming loose pulvinate mats up to 1.5 dm across, tomentose or glabrous almost throughout; leaves few to many, oblanceolate to lanceolate or narrowly spathulate, not revolute but the margins sometimes thicker than the blades or crispate, 1-4 (5) cm long, 3-6 (8) mm wide, densely white-tomentose below, lightly floccose to glabrous and green above, basal or sheathing up the stems 1 cm, the apices acute to rounded, the bases long-cuneate, gradually tapering to short petioles 2-8 mm long, the petiole-bases membranaceous, light tan, expanded and elongated, 2-4 mm long, 1-1.5 (2) mm wide, sparsely to densely tomentose without, densely tomentose within; scapes 3-5 (6) cm long, glabrous or densely matted tomentose; inflorescences capitate or nearly so, 3-4 involucres on short rays up to 1 mm long, subtended by 3 semi-foliaceous membranaceous, glabrous or tomentose, triangular bracts, 1.5-3 (4) mm long, 1-1.5 mm wide at the bases, connate; involucres turbinate-campanulate, 2-3 mm long, 1.5-2.5 (3) mm wide, glabrous without except for small patches of cottony tomentum at the base of each lobe, 5-lobed, the lobes 0.3-0.7 (1) mm long, mostly acute and triangular, margins membranaceous, erect or reflexed; perianth white to rose, 2.5-3.5 mm long, glabrous within and without, the segments nearly equal, oblong to ovate, connate about ¼ of the length of the perianth, the perianth tube dark brown to red-brown, occasionally angled; stamens exserted, 3.5-4 mm long, the filaments pilose at the bases, the anthers 0.3 mm long, oblong; achenes brown, 2.5-3.5 mm long, ovate, the globose bases tapering to 3-angled beaks.

TYPE: COLORADO: Chaffee Co.: Mt. Harvard, 1896, *F. E. Clements* 66. Holotype: NY!

Representative Specimens: COLORADO: El Paso Co.: Pikes Peak, *Snow s.n.* (PH). Gunnison Co.: Virginia Basin, *Langenheim* 285 (UC), *Langenheim* 1062 (COLO); nw of Castle Peak, *Ewan* 11750, 11757 (COLO); North Pole Basin, *Weber & Barclay* 9184 (COLO); 2 mi ne of Gothic, *Wherry s.n.* (GH). Park Co.: South Park, *Canby s.n.* (GH, NY, PH); 2 mi sw of Glentivar, *Iltis & Iltis* 18830 (COLO, WIS); 6 mi n of Fairplay, *Penland* 1320 (CAS); between Red Hill Pass and Como, *Weber* 8758 (COLO); Sulphur Spr., South Park, *Wolf & Rothrock* 27 (DS, PH, US). Saguache Co.: Cochetopa Pass, *Weber* 5795 (COLO), *Weber* 9419 (DS); 9 mi se of the Flying-M-Ranch, *Wherry s.n.* (A). *Eriogonum coloradense* is a high alpine species that is most

closely related to *E. exilifolium*, which is found to the north and at a much lower elevation.

Bibliography

Brackenridge, H. M. 1814. Views of Louisiana; together with a journal of a voyage up the Missouri River in 1811. Pittsburgh.

Bradbury, J. 1817. Travels in the interior of America, in the years 1809, 1810, 1811 . . . Liverpool.

Geyer, C. A. 1845-1846. Notes on the vegetation and general character of the Missouri and Oregon territories . . . London Journ. Bot. 4: 479-492, 653-662. 1845; 5: 22-41, 198-208, 285-310, 509-524. 1846.

Graustein, J. E. 1950. Nuttall's travels in the Old Northwest. An unpublished 1810 diary. Chronica Botanica 14: no. ½. 86 pp.

Irving, W. 1836. Astoria; or, anecdotes of an enterprise beyond the Rocky Mountains. 2 vols. Philadelphia.

Lewis, M. & W. Clark. 1814. History of the expedition under the command of Captains Lewis and Clark . . . Prepared for press by Paul Allen, Esquire; edited by Nicholas Biddle. 2 vols. Philadelphia.

Maximilian, A. P. 1841. Reise in das innere Nord-America in den Jahren 1832 bis 1834. 2 vols. Coblenz.

McKelvey, S. D. 1955. Botanical exploration of the Trans-Mississippi west, 1790-1850. Jamaica Plains, Massachusetts.

Oglesby, R. E. 1963. Manuel Lisa and the opening of the Missouri fur trade. Norman, Oklahoma.

Pennell, F. W. 1936. Travels and scientific collections of Thomas Nuttall. Bartonia 18: 1-51.

Rafinesque, C. S. 1833. Account of the botanical collections of Professor C. S. Rafinesque. Atl. Journ. & Friend of Knowl. 167-170.

Reveal, J. L. In press The subgeneric concept in *Eriogonum* (Polygonaceae). Bull. Torrey Bot. Club.

Rickett, H. W. 1950. John Bradbury's explorations in Missouri Territory. Proc. Am. Philos. Soc. 94: 59-89.

Stevens, O. A. 1946. Botanical visits to forts Clark, Mandan and Union in North Dakota. Rhodora 48: 98-103.

———. 1959. Bradbury and Nuttall, pioneer Dakota botanists. North Dakota Hist. Quart. 26:159-169.

Torrey, J. & A. Gray. 1870. A revision of the Eriogoneae. Proc. Amer. Acad. 8:145-200.

The Great Basin Naturalist

Founded in 1939 by Vasco M. Tanner

A journal published from one to four times a year by Brigham Young University, Provo, Utah.

MANUSCRIPTS: Only original, unpublished manuscripts, pertaining to the Great Basin and the western United States in the main, will be accepted. Manuscripts are subject to the approval of the editor.

ILLUSTRATIONS: All illustrations should be made with a view to having them appear within the limits of the printed page. The illustrations that form a part of an article should accompany the manuscript. All half-tones or zinc etchings to appear in this journal are to be made under the supervision of the editor, and the cost of the cuts is to be borne by the contributor.

REPRINTS: No reprints are furnished free of charge. A price list for reprints and an order form is sent with the proof.

SUBSCRIPTION: The annual subscription is $2.50 (outside the United States $3.25). Single number, 80 cents.

All correspondence dealing with manuscripts should be addressed to the Editor, Vasco M. Tanner, Great Basin Naturalist, Brigham Young University, Provo, Utah. Other matters such as subscriptions, reprints, exchanges and other business should be addressed to Ernest L. Olson, Chairman of University Publications.

REPRINTS SCHEDULE OF THE GREAT BASIN NATURALIST

	2 pp.	4 pp.	6 pp.	8 pp.	10 pp.	12 pp.	Each Additional 2 pp.
50 copies	$6.00	$7.00	$8.00	$9.00	$10.00	$11.00	$2.00
100 copies	7.00	8.00	9.00	10.00	11.00	12.00	
200 copies	8.00	9.00	10.00	11.00	12.00	13.00	
300 copies	9.00	10.00	11.00	12.00	13.00	14.00	

COVERS: $10.00 for first 100 copies, $4.00 for additional 100 copies.

TABLE OF CONTENTS

A Comparative Study of the Mountain Brush Vegetation in Utah. Illustrated. Elray S. Nixon 59

Predaceous-Scavenger Ants in Utah. D Elden Beck, Dorald M. Allred, and William J. Despain 67

New Records and Species of Neotropical Bark Beetles (Scolytidae: Coleoptera). Stephen L. Wood 79

A New Species of *Spinibdella* from Utah (Bdellidae: Acarina). Illustrated. Clive D. Jorgensen 98

Notes on *Eriogonum* - III on the Status of *Eriogonum pauciflorum* Pursh. Illustrated. James L. Reveal 102

Volume XXVII, No. 3
November 30, 1967

The

Great Basin NATURALIST

Published by
Brigham Young University

The Great Basin Naturalist
Published at Provo, Utah by
Brigham Young University

Volume XXVII November 30, 1967 No. 3

NEW RECORDS AND SPECIES OF NEOTROPICAL BARK BEETLES (SCOLYTIDAE: COLEOPTERA), PART II [1]

Stephen L. Wood[2]

While preparing a taxonomic review of the bark and ambrosia beetles (Scolytidae) of Costa Rica it was necessary to examine all available species of this group from Mexico, all of Central America, and northern South America. As a result, a large number of species new to science were recognized from areas outside of Costa Rica. In order to make names available for these species to facilitate this and other work, 23 species and one genus (*Stegomerus*) new to science are described below. The new species represent the genera *Loganius* (1), *Scolytus* (1), *Scolytodes* (10), *Stegomerus* (5), *Xyleborus* (3), *Corthylus* (1), and *Tricolus* (2). The type series of these species were collected in the following countries: Mexico (6), Guatemala (6), Honduras (3), Costa Rica (8), Panama (8), Colombia (2), and Bolivia (1). One species occurred in two countries and five were collected in three countries.

Loganius exilis, n. sp.

This species is rather closely related to *liratus* Wood, but it is distinguished by the less strongly serrate costal margins of the elytral declivity, by the more strongly elevated alternate interstriae on the elytral declivity, by the poorly developed funicular tuft of hair, and by the somewhat narrower frons.

Male.— Length 1.4 mm. (paratypes 1.3-1.6 mm.), 2.7 times as long as wide; color very dark brown.

Frons flattened or very feebly concave on lower half, convex above; surface rather coarsely, closely, deeply punctured in impressed area, more sparsely punctured above; median third of epistomal margin bearing a shining, elevated, procurved carina as in *liratus;* vestiture limited to impressed area, consisting of abundant, erect, stout, uniformly rather short setae.

1. Part of the field work relating to this study was sponsored by research grants GB-532 and GB-3678 from the National Science Foundation.
2. Department of Zoology and Entomology, Brigham Young University, Provo, Utah. Scolytoidea Contribution No. 35.

Pronotum equal in width and length; widest near base, the sides weakly arcuate and converging slightly toward the rather narrowly rounded anterior margin; surface smooth, shining, the punctures rather large, deep, moderately close, oval; glabrous.

Elytra 1.8 times as long as wide, 1.7 times as long as pronotum; sides straight and parallel on basal two-thirds, narrowly, subserrately rounded behind; striae weakly impressed, the punctures moderately large, deep; interstriae shining, slightly wider than striae, very weakly convex, the punctures uniseriate, small, widely spaced. Declivity rather steep, convex, the punctures uniseriate, small, widely spaced. Declivity rather steep, convex; striae narrower than on disc; interstriae subshining, 1, 3, 7, and 9 moderately elevated, 7 joins 9 and continues almost to 3, elevated interspaces and 2 (somewhat less) uniseriately granulate, the granules moderately large, rounded, rather widely spaced; costal margin subserrate toward apex. Vestiture restricted to declivity, sparse; consisting of rows of erect, interstrial scales, each scale about five times as long as wide.

Female.— Similar to male except frons less strongly impressed below, more broadly rounded above.

Type Locality.— Volcan de Agua, Guatemala.

Type Material.— The male holotype, female allotype, and 81 paratypes were collected at the type locality on May 19, 1964, at an elevation of 1,000 m., by S. L. Wood, from the bole and branches of a common small tree that awaits identification.

The holotype, allotype, and paratypes are in my collection.

Scolytus aztecus, n. sp.

This species appears to be allied to *ventralis* Leconte, but it is easily recognized by the very much larger size, by the two pair of projecting lobes at elytral apex; by the broad, recurved, epistomal elevation, and by other characters. This is the largest American representative of the genus.

Adult.— Presumably a female. Length 5.7 mm. (paratypes 4.7-6.3 mm.), 2.4 times as long as wide; color very dark brown, elytra reddish brown.

Frons convex, transversely impressed just above epistoma, a slight median impression at vertex; surface shining, the punctures small, rather close, substrigose above; epistoma with a distinctly elevated, dorsally arched ridge above epistomal brush, its lateral extremities blending into a marginal callus; vestiture short, sparse, inconspicuous.

Pronotum 1.03 times as long as wide; widest just behind middle, the sides very weakly arcuate, not converging until anterior third, rather strongly constricted at sides just before anterior margin, anterior margin boardly, very feebly emarginate; surface smooth, shining, the punctures fine, deep on disc, about twice as large in lateral areas; vestiture confined to lateral areas.

Elytra 1.4 times as long as wide, 1.4 times as long as pronotum; sides almost straight and parallel on basal two thirds, then converging very slightly to the rather abrupt posterolateral angles; median half of posterior outline occupied by two pairs of broad serrations, each serration half as long as wide; striae not impressed, the punctures small, deep, regular; interstriae about three to four times as wide as striae, almost flat, shining, the punctures moderately large, deep, uniseriate except confused on 2; declivity descending slightly; glabrous, except a few hairs on declivity. Venter as in female *ventralis*, except more coarsely punctured, the feeble, carinate elevation at posterior margin of sternum 2 present on all four specimens.

Male.— Not represented in the series at hand.

Type Locality.— Twenty-seven miles east of Morelia, Michoacan, Mexico.

Host.— *Abies religiosa.*

Type Material.— The female holotype and three female paratypes were taken at the type locality on June 14, 1965, at an elevation of about 2,600 m., by S. L. Wood, from biramous, transverse egg tunnels in the bole of a standing fir tree about 60 cm. in diameter.

The holotype and paratypes are in my collection.

Scolytodes clusiacolens, n. sp.

This species is more closely allied to *clusiae* Wood than to other known species, but it may be distinguished by the larger size, by the coarsely, deeply punctured pronotum and elytra and, in the female, by the weakly convex frons.

Female.— Length 2.3 mm. (paratypes 1.8-2.9 mm.), 2.5 times as long as wide; color black.

Frons plano-convex from a point well below upper level of eyes to epistoma, convex above that point, the transition rather abrupt; surface reticulate, finely, deeply, rather closely punctured; vestiture inconspicuous, consisting of very fine, moderately abundant, uniformly distributed hair.

Pronotum 1.1 times as long as wide; sides almost straight or very feebly constricted on basal two-thirds, broadly rounded in front; dorsal profile weakly arched from base, more strongly declivous on anterior fifth; surface reticulate, with rather coarse deep punctures from base to near anterior margin, gradually replaced by smaller punctures laterally and minute asperities medially on anterior fifth; glabrous except near lateral and anterior margins.

Elytra 1.5 times as long as wide, 1.5 times as long as pronotum; sides almost straight and parallel on basal two-thirds, rather narrowly rounded behind; striae impressed, the punctures rather large, deep; interstriae slightly narrower than striae, convex, shining, the punctures fine, sharply but not deeply impressed, uniseriate, some of them slightly subgranulate on anterior margins (variable in the series). Declivity convex, rather steep; striae 1 only distinctly impressed, the punctures distinctly smaller than on disc; interstrial

punctures minute, clearly impressed. Vestiture fine, hairlike, abraded on disc of type, in regular strial and interstrial rows on teneral specimens.

Male.— Similar to female except frons convex to transverse impression just above epistoma, the punctures larger, deeper, the vestiture almost confined to epistomal area; more nearly subgranulate interstrial punctures.

Type Locality.— About 10 km. east of Volcan Paracutin, Michoacan, Mexico.

Host.—*Clusia* sp.

Type Material.— The female holotype, male allotype and 66 paratypes were taken at the type locality on June 19, 1965, at an elevation of about 2,500 m., by S. L. Wood, from *Clusia* twigs and branches. Other paratypes include 16 from Volcan Pacaya, Guatemala, June 1, 1964, 1,300 m., from *Clusia;* 1 from Cerro Peña Blanca, Honduras, May 23, 1964, 2,000 m., from *Clusia.*

The holotype, allotype, and paratypes are in my collection.

Scolytodes clusiavorus, n. sp.

This species is rather closely related to *clusiae* Wood, but may be distinguished by the smaller size, by the more sharply, somewhat more deeply punctured pronotum and elytra, particularly the elytral declivity and, in the female, by the less deeply, less extensively concave frons.

Female.— Length 1.5 mm. (paratypes 1.3-1.6 mm.), 2.6 times as long as wide; color black.

Frons shallowly, broadly plano-concave from just below upper level of eyes to epistoma; surface subshining, closely, finely, deeply, uniformly punctured from vertex to epistoma; vestiture consisting of rather coarse, moderately long, uniformly but rather sparsely distributed hair.

Pronotum 1.1 times as long as wide; sides almost straight or very feebly constricted on posterior two-thirds, broadly rounded in front; surface reticulate, the punctures rather fine, deep, moderately close, the anterior fifth more strongly declivous with a few minute asperities in median area, the punctures attaining anterior margin only in lateral areas; vestiture confined to anterior and lateral areas.

Elytra 1.5 times as long as wide, 1.6 times as long as pronotum; sides almost straight and parallel on basal two-thirds, narrowly rounded behind; striae not impressed, the punctures moderately large, deep; interstriae slightly narrower than striae, almost smooth, with some irregular lines, the punctures minute, almost uniseriate, not at all granulate. Declivity convex, rather steep; strial punctures smaller and shallower than on disc. Vestiture consisting of rows of minute strial hairs and longer, erect rows of coarser interstrial hair.

Male.— Similar to female except frons strongly convex, reticulate, the punctures rather coarse, sparse, vestiture restricted to epistomal margin.

Type Locality.— Volcan de Agua, Guatemala.

Host.— *Clusia* sp.

Type Material.— The female holotype, male allotype, and three paratypes were collected at the type locality on May 19, 1964, at an elevation of 1,000 m., by S. L. Wood, from the phloem of small branches of a small *Clusia* tree.

The holotype, allotype, and paratypes are in my collection.

Scolytodes perditus, n. sp.

This species is more closely allied to *cecropiacolens* Wood than to other known species, but it is easily distinguished by the more slender body form, by the less deeply impressed, finer punctures on pronotum and elytra and, in the female, by the dense, long brush of frontal hair arising above the eyes.

Female.— Length 2.0 mm. (paratypes 1.6-2.1 mm.), 2.1 times as long as wide; color yellowish brown, the anterior fourth of prothorax darker.

Frons flattened from well above upper level of eyes to epistoma, with low, submarginal, longitudinal carinae extending from epistoma about half the distance to upper level of eye; central area minutely granulate, lateral areas with a few punctures; vestiture consisting of abundant, coarse, long, subplumose setae mostly arising above eyes, none as low as level of antennal bases, some of the setae sufficiently long to reach epistoma.

Pronotum 1.1 times as long as wide; widest at base, sides almost straight, converging very slightly anteriorly, rather narrowly rounded in front; slightly less than anterior half very finely, closely asperate; posterior area reticulate, the punctures rather fine, shallow; glabrous.

Elytra 1.2 times as long as wide, 1.2 times as long as pronotum; sides straight and parallel on slightly more than basal half, rather narrowly rounded behind; striae not impressed, the punctures small, sharply but not deeply impressed, the strial punctures almost indistinguishable from the similar, abundant, confused, interstrial punctures; surface almost smooth, shining. Declivity convex, rather steep; strial punctures deeper than on disc, not reduced; interstrial punctures distinctly smaller, uniseriate except near upper area. Vestiture restricted to a few setae on sides.

Male.— Similar to female except frons convex, with a transverse impression just above epistoma but interrupted by a small subcarinate median elevation; surface smooth, shining, the punctures rather coarse, deep; strial punctures on disc deeper and somewhat larger than those of striae.

Type Material.— Fort Clayton, Canal Zone, Panama.

Host.— *Cecropia* sp.

Type Material.— The female holotype, male allotype, and 16 paratypes were collected at the type locality on December 22, 1963,

at an elevation of about 30 m., by S. L. Wood, from the terminals of *Cecropia* branches.

The holotype, allotype, and paratypes are in my collection.

Scolytodes nanellus, n. sp.

This species is somewhat allied to *pumilus* Wood, but it is much smaller, much less coarsely punctured, and the female frons is armed by a pair of submarginal, longitudinal carinae below and by a brush of long hair above upper level of eyes.

Female.— Length 1.0 mm. (female paratype 1.0 mm.; males 0.9 mm.), 2.4 times as long as wide; color medium brown.

Frons flattened from upper level of eyes to epistoma, with submarginal, low carina extending from epistoma almost to upper level of eyes; surface subshining, very finely and closely punctured; vestiture consisting of rather abundant, coarse, subplumose setae, confined to area near or above upper level of eyes, some of setae almost reaching epistomal margin.

Pronotum 1.1 times as long as wide; widest just behind middle, the sides feebly arcuate, rather broadly rounded in front; summit distinctly in front of middle, very finely asperate in front, posterior area rather coarsely reticulate, the punctures rather fine, not deep; glabrous.

Elytra 1.4 times as long as wide, 1.3 times as long as pronotum; sides almost straight and parallel on slightly more than basal half, rather narrowly rounded behind; striae 1 weakly, others not impressed, the punctures small, not deep; interstriae slightly wider than striae, shining, almost smooth, the punctures fine, not always clearly impressed. Declivity convex, rather steep; all punctures somewhat reduced. Vestiture consisting of a few scattered bristles on or near declivity.

Male.— Similar to female except frons convex, with a slight transverse impression just above epistoma, surface subreticulate, the minute punctures obscure, vestiture reduced, confined to epistomal area.

Type Locality.— Barro Colorado Island, Canal Zone, Panama.

Type Material.— The female holotype, male allotype, and two paratypes were collected on December 27, 1963, at an elevation of about 70 m., by S. L. Wood, from phloem tissues of an unidentified tree branch.

The holotype, allotype, and paratypes are in my collection.

Scolytodes venustulus, n. sp.

This species appears to be closely related to *venustus* Wood, but is distinguished by the smaller size, by the reticulate, less closely punctured posterior area of the pronotum, by the unimpressed elytral striae and by the almost equal size of strial and interstrial punctures.

Male.— Length 1.5 mm. (male paratypes 1.3-1.5 mm.), 2.3 times as long as wide; color dark brown, with a slight reddish cast.

Frons convex, with a transverse impression just above epistoma; surface smooth and shining to a level above eyes, the punctures very fine; vestiture fine, hairlike, largely confined to epistomal area.

Pronotum 1.0 times as long as wide; widest just behind middle, the sides rather weakly arcuate on basal two-thirds, rather narrowly rounded in front; dorsal profile arched from base, a little more strongly declivous on anterior fourth; surface reticulate, with rather coarse, deep, moderately close punctures on basal two-thirds, finely, closely asperate in median area in front, the punctures reaching anterior margin in lateral areas; punctures on disc separated by distances about equal to their own diameters; glabrous.

Elytra 1.5 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel on slightly more than basal half, rather narrowly rounded behind; base of suture just behind scutellum acutely but not strongly elevated; striae not impressed, the punctures moderately large, deep; interstriae slightly wider than striae, smooth and shining, the punctures fine, distinct. Declivity convex, rather steep; strial punctures reduced; interspace 2 narrow, not wider than diameter of a strial puncture (noticeably wider on one paratype). Vestiture consisting of minute strial and interstrial hairs, and longer, erect, bristles on declivital interspaces 1, 3, 5, and 7. Interspace 10 ending before level of hind coxa.

Female.— Not represented in the series at hand.

Type Locality.— Cerro Punta on Volcan Baru (Chiriqui), Panama.

Host.—*Oreopanax* sp.

Type Material.— The male holotype and three male paratypes were collected at the type locality on January 11, 1964, at an elevation of about 1,800 m., by S. L. Wood, from phloem of a young *Oreopanax* sapling about 5 cm. in diameter.

The holotype and paratypes are in my collection.

Scolytodes ficivorus, n. sp.

This species is very closely related to *schwarzi* (Hopkins), but it may be distinguished by the more coarsely punctured, less shining pronotum and elytra, by the reticulate pronotal disc, by the more finely asperate anterior area of the pronotum, and by the somewhat more coarsely punctured marginal areas of the female frons. Additional data eventually may prove this to be only a subspecies of *schwarzi*.

Female.— Length 1.6 mm. (paratypes 1.5-1.7 mm.), 2.3 times as long as wide; color yellowish brown.

Except for the characters noted in the above diagnosis this species appears to be identical to *schwarzi*.

Male.— Similar to female except frons convex, reticulate, obscurely punctured, with frontal vestiture greatly reduced.

TYPE LOCALITY.— Palin, Escuintla, Guatemala.

HOST.— *Ficus* sp.

TYPE MATERIAL.— The female holotype, male allotype, and two male paratypes were collected at the type locality on May 19, 1964, at an elevation of about 300 m., by S. L. Wood, from a small, broken fig branch.

The holotype, allotype, and paratypes are in my collection.

Scolytodes facetus, n. sp.

This species is very closely related to *ficivorus* Wood, described above, but is distinguished by the very fine, somewhat obscure punctures of pronotum and elytra, by the slightly longer and more abundant vestiture on the female frons, and by the more narrowly separated eyes. Except for the fact that the two type series of this species and *ficivorus* were taken with two other species of *Scolytodes* from the same small branch, the differences are of such a nature that they might possibly be considered geographical replacements of one another.

FEMALE.— Length 1.6 mm. (male paratypes 1.4-1.5 mm.), 2.3 times as long as wide; color yellowish brown.

In addition to the characters noted in the above diagnosis, this species differs from *ficivorus* in having the eyes separated by 1.6 times the width of an eye (2.6 times in *ficivorus*), and the elytra are reticulate, with the punctures shallow and with those of the interspaces obscure. The obscure, minute pronotal punctures are separated by distances at least twice their own diameters (this distance less than the diameter of a puncture in *ficivorus*).

MALE.— Similar to female except male frons convex, reticulate, obscurely punctured; eyes separated by 2.1 times the width of an eye (3.1 in *ficivorus*).

TYPE LOCALITY.— Palin, Escuintla, Guatemala.

HOST.— *Ficus* sp.

TYPE MATERIAL.— The female holotype, male allotype, and two male paratypes were taken at the type locality on May 19, 1964, at an elevation of about 300 m., by S. L. Wood, from the same small branch of a native fig tree that contained the type series of *ficivorus*.

The holotype, allotype, and paratypes are in my collection.

Scolytodes ingavorus, n. sp.

This species is rather closely related to *ficivorus* Wood, described above, but it may be distinguished by the pubescent elytra, by the deeper punctures on the pronotal disc and, in the female, by the much more heavily pubescent frons that lacks a shining glabrous area at the center.

FEMALE.— Length 1.6 mm. (paratypes 1.3-1.7 mm.), 2.3 times as long as wide; color yellowish brown, with anterior half of pronotum darker.

Frons flattened from upper level of eyes to the somewhat elevated epistoma, with a pair of submarginal, low, longitudinal carinae (or elevations; obscured by vestiture) extending dorsad from epistomal margin, its upper limits obscured by vestiture; surface smooth and shining with fine punctures below, becoming finely granulate and obscurely punctured in central area above; vestiture consisting of abundant, long, coarse, subplumose setae above upper level of eyes, continuing on lateral areas to epistomal margin as somewhat shorter setae, central area bearing shorter, fine, moderately abundant, hairlike setae.

Pronotum 1.1 times as long as wide; sides almost straight and parallel on slightly less than basal two-thirds, rather broadly rounded in front; summit just in front of middle, the anterior area rather coarsely asperate, the interior margin armed by an almost continuous ridge; posterior areas reticulate, the punctures coarse, deep, close, separated from one another by less than half the diameter of a puncture; scanty hairlike setae confined to sides and asperate area.

Elytra 1.3 times as long as wide, 1.2 times as long as pronotum; sides almost straight (feebly arcuate) and parallel on slightly less than basal two-thirds, broadly rounded behind; striae not impressed, the punctures coarse, distinctly but shallowly impressed; interstriae slightly wider than striae, the punctures uniseriate, almost identical to those of striae. Declivity steep, convex; all punctures reduced, in rows; surface shining. Vestiture consisting of fine, short, erect strial and interstrial hair, and longer interstrial hair on declivity.

Male.— Similar to female except frons broadly convex, transversely impressed just above epistoma; short vestiture on declivity stout, almost scalelike.

Type Locality.— Los Corchos, Nayarit, Mexico.

Host.— *Inga* sp.

Type Material.— The female holotype, male allotype, and 43 paratypes were collected at the type locality on July 10, 1965, at an elevation of less than 10 m., by S. L. Wood, from the phloem of *Inga* branches.

The holotype, allotype, and paratypes are in my collection.

Scolytodes proximus, n. sp.

This species is rather closely related to *tenius* Wood, but may be distinguished by the very minute, obscure punctures on the pronotal disc, by the finer, shallower, elytral punctures, by the finer elytral vestiture, and by the less abundant vestiture on the female frons.

Female.— Length 1.8 mm. (paratypes 1.7-1.9 mm.), 2.8 times as long as wide; color dark brown.

Frons narrowly plano-concave from below upper level of eyes to epistoma; surface reticulate, obscurely punctured; vestiture scanty, consisting of fine, rather sparse, long hair uniformly distributed from upper level of eyes to epistoma.

Pronotum 1.1 times as long as wide; widest slightly in front of middle, sides feebly constructed on posterior half, rather broadly rounded in front; summit indefinite, about one-third from anterior margin; surface reticulate, minutely, sparsely punctured, anterior third finely asperate; anterior margin armed by a series of low, indefinite teeth; glabrous except a few setae in asperate area.

Elytra 1.7 times as long as wide, 1.7 times as long as pronotum; sides almost straight and parallel on slightly more than basal two-thirds, rather narrowly rounded behind; striae not impressed, the punctures rather fine, shallow, obscure; interstriae as wide as striae, somewhat irregular, subshining, the punctures fine, uniseriate, obscure. Declivity convex, steep; the punctures obscure, about as on disc. Vestiture consisting of minute, recumbent strial and interstrial hair, and longer, erect, sparse, interstrial hair.

Male.— Similar to female except frons convex, with a transverse impression above epistoma, the surface reticulate with fine, obscure punctures.

Type Locality.— Base of Volcan Baru (Chiriqui) near El Hato del Volcan, Panama.

Host.—*Clusia* sp.

Type Material.— The female holotype, male allotype, and 31 paratypes were collected at the type locality on January 11, 1964, at an elevation of about 1,500 m., by S. L. Wood, from the phloem of twigs and branches of a *Clusia* tree.

The holotype, allotype, and paratypes are in my collection.

Scolytodes amoenus, n. sp.

Superficially, this species resembles *multistriatus* Wood, but it is brightly shining, has the declivity more gradual, the female frons is entirely different, and the tenth interspace is acutely elevated to the declivity. Among species with an asperate anterior slope of the pronotum, continued tenth elytral interspace, and a tubercle on the posterior face of the front tibia, this species is unique. The large size, the multistriate elytra and the unique female frons also help to distinguish this unusual species.

Female.— Length 2.0 mm. (paratypes 1.9-2.3 mm.), 2.2 times as long as wide; color of basal third of pronotum, most of elytra and most of body yellowish brown, with head, anterior two-thirds of pronotum, all margins of each elytron and some parts of meso- and metasternum dark brown (variable in series).

Frons flattened from just above upper level of eyes to epistoma; most of area between eyes occupied by a very finely granulate, perfect circle extending from upper level of eyes to epistoma; lower half of circle bearing on its lower half a smooth, shining, transverse, procurved band with small, median, orad extension, this area about equal to half the width of circle; area outside of circle rather coarsely, very closely punctured; vestiture consisting of equally long, fine,

plumose setae on a continuous band surrounding circular area, numerous additional setae along epistoma; central area glabrous.

Pronotum 1.1 times as long as wide; widest at base, the sides very feebly arcuate, almost straight, and converging anteriorly very slightly on basal two-thirds, rather narrowly rounded in front; indefinite summit near middle, anterior fourth finely asperate; anterior margin armed by a continuous ridge; posterior areas obscurely subreticulate, coarsely, deeply, closely punctured, the punctures separated by slightly less than their own diameters; glabrous except near lateral and anterior margins.

Elytra 1.3 times as long as wide, 1.2 times as long as pronotum; sides almost straight and parallel on basal half, rather narrowly rounded behind; elytra with basal margin marked by a fine, raised line; striae 1 weakly, others not impressed, the punctures rather fine, deep; interstriae shining, one and one half times as wide as striae, the punctures rather fine, deep, rather abundant, confused. Declivity convex, steep; striae 1 strongly impressed; all punctures reduced, those of striae little larger than the abundant interstrial punctures. Glabrous except at sides.

Male.— Similar to female except frons convex, with a transverse impression just above epistoma, surface reticulate with coarse deep punctures above, a few granules below.

Type Locality.— Thirty-five km. north of Juchitlan, Jalisco, Mexico.

Host.— *Ficus* sp.

Type Material.— The female holotype, male allotype, and 66 paratypes were collected at the type locality on July 3, 1965, at an elevation of about 1,300 m., by S. L. Wood, from fig branches.

The holotype, allotype, and paratypes are in my collection.

Stegomerus, n. g.

This genus superficially resembles several genera in the Cryphalini and the Micracini, but it is sufficiently unique that a question exists concerning the tribal group to which it should be assigned. Schedl (personal communication) placed it in the specialized Micracini because the pronotum lacks a finely raised, basal and lateral line; I include it with the primitive Cryphalini, near *Cryphalomorphus* Schaufuss, because the anterior coxae are contiguous, because the eye is emarginate, because of the *Cryphalus*-like antennae, and because fimbriate hairs are absent from the head.

Description.— Head subglabrous; frons convex, slightly impressed in male. Eye very long, broadly emarginate, finely granulate. Antennal scape rather short, club-shaped; funicle 5-segmented, the distal segments not conspicuously wider. Pronotum coarsely asperate on anterior slope, the anterior margin usually armed; summit well defined; basal and lateral margins rounded, not marked by a fine lateral line. Elytra elongate, costal margins descending behind. Anterior tibiae gradually widened on basal two-thirds, obliquely

narrowed toward apex, the lateral margin armed by several small teeth on distal two-thirds; third tarsal segments narrow, laterally compressed. Monogamous; phloeophagous in vines and lianas.

TYPE-SPECIES.— *Stegomerus vulgaris* Wood, described below.

1. Interstrial scales and hair in uniseriate rows on disc and declivity; striae clearly evident; small species, usually less than 1.2 mm. ..... PYGMAEUS
   Elytral vestiture and punctures abundant, confused at least on declivity; usually larger than 1.4 mm. 2

2(1). Setae on basal half of elytral interspaces 9 and 10 consisting of fine, long hair; suture 2 on antennal club much more strongly procurved than suture 1; scales on elytral disc almost in uniseriate rows 3
   Setae on basal half of elytral interspaces 9 and 10 primarily scalelike, short; sutures 1 and 2 on antennal club equally, weakly procurved; scales on elytral disc abundant, confused 4

3(2). Smaller, 1.3-1.6 mm.; scales on declivital interspaces 2 and 3 mostly uniseriate; punctures of striae and interstriae somewhat smaller, essentially in in rows; in *Canavalia villosa* ..... CHIRIQUENSIS
   Larger, 1.8-2.1 mm.; scales on all declivital interspaces strongly confused; punctures of striae and interstriae coarser, completely confused; in *Muelenbeckia tamnifolia* ..... MONTANUS

4(2). Scales on at least some of discal interstriae between 3 and 9 in uniseriate rows; declivital scales broad, usually less than twice as long as wide, the apex of each scale truncate ..... MEXICANUS
   Scales on all discal interstriae multiple, confused; declivital scales more than twice as long as wide, the apex of each scale rounded ..... VULGARIS

Stegomerus pygamaeus, n. sp.

As indicated in the key, this species is distinguished from others in the genus by its small size, and by the uniseriate strial and interstrial punctures, with the elytral scales and hair in rows.

MALE.— Length 1.1 mm. (paratypes 0.9-1.2 mm.), 2.5 times as long as wide; color dark brown, the summit of pronotum and the elytra somewhat lighter.

Frons narrow, convex above, flat below, the epistomal margin and its obtuse, median lobe slightly elevated; surface reticulate above, subreticulate below, and finely, sparsely punctured; vestiture on flattened area moderately abundant, consisting of fine, rather long

hair. Eye elongate, about three times as long as wide; shallowly, broadly emarginate; rather finely faceted. Antennal scape shorter than the 5-segmented funicle; club marked by three equally, slightly procurved sutures.

Pronotum 1.0 times as long as wide; widest one-third of length from base, the sides weakly arcuate, broadly rounded in front; armature on anterior margin poorly developed; summit at middle, prominent; anterior area rather coarsely asperate; posterior and lateral areas almost smooth and shining, with small, rounded, isolated granules; vestiture consisting of hairlike setae over entire surface with erect scales intermixed on posterior half.

Elytra 1.4 times as long as wide, 1.5 times as long as pronotum; sides straight and parallel on more than posterior two-thirds, rather broadly rounded behind; striae 1 feebly, others not impressed, the punctures small, shallow; interstriae slightly wider than striae, the punctures fine, uniseriate. Declivity moderately steep, convex; similar to disc except strial and interstrial punctures smaller and somewhat obscure. Vestiture consisting of uniseriate rows of short, semirecumbent, strial hair and erect interstrial scales, each scale about three times as long as wide.

Female.— Similar to male except lower half of frons more nearly convex.

Type Locality.— Los Corchos, Nayarit, Mexico.

Host.—*Canavalia villosa* (type), *Cestrum scandans* (paratype), and *Dioclea megacarpa* (paratype).

Type Material.— The male holotype, female allotype, and 35 paratypes were collected at the type locality from stems of the above host on July 10, 1965, at an elevation of about 20 m., by S. L. Wood. Eight paratypes were collected at Zamorano, Morazan. Honduras, on April 18, 1964, from *Dioclea megacarpa*, elevation 700 m.; one paratype bears the same date but was taken from *Canavalia villosa;* two paratypes were taken at La Lima, Cortez, Honduras, on May 5, 1965, from *Cestrum scandens;* all were collected by S. L. Wood. One specimen, not included in the type series, was taken at San Jose, San Jose Prov., Costa Rica, on October 22, 1963, at an elevation of 1,600 m., evidently from *Canavalia villosa.*

The holotype, allotype, and paratypes are in my collection.

Stegomerus chiriquensis, n. sp.

As indicated in the key this species is allied to *montanus*, described below, but it may be distinguished by the smaller size, and by the different arrangement of elytral punctures and scales.

Male.— Length 1.4 mm. (paratypes 1.3-1.6 mm.), 2.6 times as long as wide; color light brown, a few paratypes much darker.

Frons convex above, rather strongly, transversely impressed near middle, flattened below; a median epistomal lobe present; surface reticulate, with moderately abundant, fine, obscure punctures; vesti-

ture fine, rather sparse. Eye elongate, about three times as long as wide; broadly, rather deeply emarginate; rather coarsely faceted. Antennal scape shorter than the 5-segmented funicle; club large, longer than combined length of scape and funicle, three procurved sutures subangulate at middle, the first partly septate.

Pronotum as in *pygmaeus*, except anterior margin armed by a series of about six small teeth.

Elytra 1.6 times as long as wide, 1.7 times as long as pronotum; punctures of striae and interstriae very close, moderately large and deep, in obscure rows. Declivity rather steep, convex; strial punctures slightly smaller and interstrial punctures much smaller on disc, shallow, in rows. Vestiture consisting of uniseriate rows of short, fine, recumbent strial hair and longer, erect interstrial scales, each scale four or five times as long as wide; sutural margin on declivity with an additional row of shorter scales; an occasional scale on declivity not in the rows.

Female.— Similar to male except transverse frontal impression obscure or absent.

Type Locality.— Cerro Punta, Chiriqui, Panama.

Host.— *Canavalia villosa.*

Type Material.—The male holotype, female allotype, and 47 paratypes were collected at the type locality along Rio Viejo on January 11, 1964, at an elevation of 1,800 m., by S. L. Wood from stems of the above host.

Stegomerus montanus, n. sp.

As indicated in the above key this species is distinguished from the closely allied *chiriquensis* Wood by the larger size and by the different arrangement of elytral setae.

Male.— Length 2.0 mm (paratypes 1.8-2.1 mm.), 2.6 times as long as wide; color dull black or grayish black, with elytra and summit of pronotum having a reddish cast.

Frons, eye, and antenna as in *chiriquensis.*

Pronotum 1.0 times as long as wide; widest on basal fourth, the sides very feebly arcuate and converging slightly toward the rather narrowly rounded anterior margin; summit at middle, impressed behind; surface and vestiture about as in *chiriquensis.*

Elytra 1.5 times as long as wide, 1.7 times as long as pronotum; disc densely, deeply, rather finely punctured, the punctures separated by distances less than half the width of a puncture, confused. Declivity rather steep, convex; striae and interstriae not distinguishable, the punctures obscure. Vestiture consisting of rows of minute, strial hair between confused rows of slender scales; setae on interspaces 9 and 10 from base to declivity consisting of fine hair only.

Female.— Similar to male except frons flattened, not transversely impressed.

Type Locality.— Volcan Irazu, Cartago Prov., Costa Rica.

Host.— *Muelenbeckia tamnifolia.*

Type Material.— The male holotype, female allotype, and 15 paratypes were collected from the above locality and host on June 28, 1963, at an elevation of 2,800 m., by S. L. Wood. Fourteen additional paratypes were collected at Villa Mills on Cerro de la Muerte, Cartago Prov., Costa Rica, on August 1, 1966, at 3,000 m. elevation by S. L. Wood.

Habits.— This species inhabits the cambium region or the outer woody layers of stems larger than about 1 cm. of the host, a woody vine (or liana). The beetles are monogamous; each pair constructs an H-shaped system of egg galleries, with the entrance tunnel entering on the short transverse bar and the arms extending parallel to the grain of the wood. The larvae feed in the phloem tissues and usually construct tunnels parallel to the grain of the wood. Young adults commonly tunnel into the deeper tissues.

Stegomerus mexicanus, n. sp.

This species is closely allied to *vulgaris* Wood, described below, but it is distinguished by the shape and arrangement of the elytral scales as indicated in the above key.

Male.— Length 1.7 mm. (paratypes 1.4-1.7 mm.), 2.5 times as long as wide; color rather light brown, some specimens dull black, with light vestiture.

Frons, eye, antennal scape and funicle as in *chiriquensis;* antennal club large, 1.3 times as long as wide, with three equally, weakly procurved sutures indicated.

Pronotum as in *chiriquensis*, but narrowly rounded in front, armed by four large teeth.

Elytra 1.5 times as long as wide, 1.7 times as long as pronotum; sides straight and parallel on basal three-fourths, broadly rounded behind; disc with shallow, confused, close indefinite punctures. Declivity rather steep, convex; surface as on disc except punctures evidently very feebly granulate. Vestiture consisting of uniseriate rows of fine, strial hair and confused rows of erect interstrial scales, at least some of the rows between interspaces 4 and 9 uniseriate; each scale about three to four times as long as wide.

Female.— Similar to male except frons not as strongly flattened.

Type Locality.— Twenty-one km. west of Morelia, Michoacan, Mexico.

Host.— *Serjania* sp.

Type Material.— The male holotype, female allotype, and 51 paratypes were taken at the type locality on June 15, 1965, at an elevation of 2,300 m., by S. L. Wood, from *Serjania* stems less than 1 cm. in diameter.

The holotype, allotype, and paratypes are in my collection.

Stegomerus vulgaris, n. sp.

In the above key this species is placed near *mexicanus* Wood, but it is distinguished by the shape and arrangement of the elytral scales.

Male.— Length 2.0 mm. (paratypes 1.7-2.0 mm.), 2.6 times as long as wide; color light brown, some specimens with areas almost dull black.

Frons weakly convex, slightly impressed just above epistoma; epistomal process evident, projecting very slightly as a median epistomal lobe; surface coarsely reticulate, with moderately large, indefinite, isolated granules in central area, reduced in marginal areas. Eye three times as long as wide; coarsely faceted; about one-fourth divided by a broad emargination. Antennal scape and 5-segmented funicle short, subequal in length, their combined lengths distinctly less than length of club; club subcircular, 1.1 times as long as wide, divided into four subequal segments by three broadly procurved sutures, suture 1 partly septate at both ends.

Pronotum 1.0 times as long as wide; widest one-third of length from base; basal angles rounded, sides rather strongly, arcuately converging toward the narrowly rounded anterior margin; anterior margin armed by about six teeth; oval area on anterior slope coarsely asperate; summit elevated, near middle; posterior areas subreticulate-granulate, with moderately large, rather close, rounded granules; vestiture hairlike, except mixed with scales on basal fourth.

Elytra 1.7 times as long as wide, 1.8 times as long as pronotum; scutellum rather large triangular, flat; sides straight and parallel on basal three-fourths, somewhat narrowly rounded behind; disc closely, obscurely punctured, the punctures shallow, confused. Declivity rather steep, convex; striae 1 and 2 obscurely indicated (largely by color), otherwise similar to disc. Vestiture consisting of small, obscure, uniseriate rows of strial hair and abundant, confused, erect, interstrial scales, each scale about four times as long as wide.

Female.— Similar to male except frons very slightly, more strongly convex.

Type Locality.— Volcan Zunil, Quezaltenango, Guatemala.

Host.— An unidentifiable woody vine or liana (type); *Serjania mexicana* and *S. triquetra* (paratypes).

Type Material.— The holotype, allotype, and 66 paratypes were collected at the type locality on May 27, 1964, at an elevation of 1,000 m., by S. L. Wood, from an unidentifiable cut, woody vine about 3-5 cm. in diameter. Other paratypes include 15 from San Lucas, Paraiso, Honduras, April 22, 1964, 800 m., from *Serjania mexicana;* 17 from Zamorano, Morazan, Honduras, April 18, 1964, 700 m., from *Serjania triquetra;* 1 from Palin, Esquintla, Guatemala, May 19, 1964, 350 m., from *Serjania* sp.; 33 from San Jose, San Jose Prov., Costa Rica, October 22, 1963, 1,300 m., evidently from

Serjania sp.; and 14 from Tapanti, Cartago Prov., Costa Rica, August 17, 1963, 1,300 m., evidently from *Serjania* sp.

The holotype, allotype, and paratypes are in my collection.

HABITS.— Essentially as described above for *montanus*.

Xyleborus horridatus, n. sp.

This species is very closely related to *horridus* Eichhoff, but it may be distinguished by the more slender body, by the more finely sculptured pronotum and elytral disc, and by the more broadly impressed, more coarsely and shallowly punctured elytral declivity that lacks a submarginal, lateral row of fine tubercles. Specimens labeled *horridus* from southern Central America probably are of this species

FEMALE.— Length 4.2 mm. (female paratypes 3.7-4.3 mm.), 2.3 times as long as wide; color rather dark reddish brown.

Frons rather evenly, broadly convex from epistoma to vertex, the surface reticulate, rather deeply, somewhat obscurely punctured; almost glabrous, except a few fine setae near epistoma.

Pronotum 1.0 times as long as wide; widest one-third from base, the sides moderately arcuate from base to the somewhat narrowly rounded anterior margin; summit behind middle closely asperate from anterior margin to summit; posterior areas smooth and shining, with small, sharply but shallowly impressed punctures; disc glabrous, a few inconspicuous, hairlike setae in marginal areas.

Elytra 1.6 times as long as wide, 1.6 times as long as pronotum; sides straight and diverging slightly to middle, then converging slightly to a level near apex, then rather abruptly, very broadly rounded behind; striae 1 slightly, others not at all impressed, the punctures small, clearly impressed; interstriae about four times as wide as those of striae, shining, transversely wrinkled (particularly 1 and 2). Declivity beginning slightly in front of middle on interspaces 1 and 2, increasing in width and steepness posteriorly; apical and lateral margins acute on lower third, rather abrupt on middle third, broadly rounded above, the margins distinctly, not strongly elevated; declivital face similar to but broader than in *horridus*, the median tubercles (2 pair of larger ones near middle, with 1 very fine pair below and 3 above these) about as in *horridus*, lateral tubercles just within lateral margin almost entirely absent. Vestiture fine; scanty, particularly on declivity (abundant on declivity in *horridus*).

MALE.— Length 3.3 mm. (male paratype 3.5 mm.); frons medially impressed on upper half; eye reduced; anterior third of pronotum concavely excavated, the anterior margin elevated and armed by one median, subacute process, the asperites reduced within the concavity; elytra evidently somewhat shorter, otherwise similar to female.

TYPE LOCALITY.— San Isidro del General, San Jose Prov., Costa Rica.

HOST.— *Citrus* sp.

Type Material.— The female holotype, male allotype, and 16 paratypes were collected at the type locality on December 5, 1963, at an elevation of about 1,000 m., by S. L. Wood, from Naranjo dulce. Additional paratypes were taken as follows: 5 at Dominical, Puntarenas, December 9, 1963, and 1 Pandora, Limon Prov., Costa Rica, August 23, 1963, by S. L. Wood, from an unknown woody vine and a log; 1 at Hamburg Farm, Sta. Clara Pr., Costa Rica, June 10, 1928, by Nevermann; 9 at Finca El Encanto, La Plata Huila, Colombia, April 28, 1959, by B. Humides, from Naranjo dulce (*Citrus* sp.); 1 from Barro Colorado Island, Canal Zone, Panama, February 26, 1929, by S. W. Frost.

The holotype, allotype, and paratypes are in my collection.

Xyleborus horridicus, n. sp.

The only species known to me that are even remotely related to this are *horridus* Eichhoff and *horridatus* Wood, described above. It may be distinguished from those species by the larger size, and by the very different elytral declivity.

Female.— Length 6.5 mm., 2.5 times as long as wide; color reddish brown.

Frons rather narrow, moderately convex from epistoma to vertex; surface subshining, punctate-granulate; vestiture fine, rather sparse, epistomal brush rather well developed. Eye coarsely faceted; one-third divided by an emargination.

Pronotum 1.1 times as long as wide; widest about a third from base, very feebly arcuate on basal third, more strongly arcuate and converging on middle third, rather narrowly rounded in front; summit just behind middle, anterior area rather finely asperate; posterior area shining, finely punctured. Vestiture fine, erect, sparse on disc, more abundant and longer in lateral areas.

Elytra 1.4 times as long as wide, 1.4 times as long as pronotum; sides straight on basal half, slightly wider just behind middle, arcuate and narrowed slightly to level of sutural apex, then abruptly, broadly, subemarginately truncate behind; striae not impressed, the punctures small, moderately deep, somewhat staggered; interstriae shining, irregular, about three times as wide as striae, the punctures somewhat staggered, some granulate on 1-3. Declivity beginning very slightly in front of middle, rather gradual; upper half broadly flattened, the margins rounded, not at all elevated; lower half with lateral margins very strongly elevated, abruptly above, the summit dorsally pointed as seen in profile, the elevation decreasing gradually below to apex of suture; punctures in the broadly excavated area moderately large, shallow, confused; upper third armed by one pair of moderately large tubercles in line with striae 2, a few additional small tubercles near declivital margin on interspaces 1-3. Vestiture fine, confined to lateral areas except for a few minute, recumbent hairs in excavated area of declivity.

Type Locality.— Reyes, Bolivia.

Type Material.— The female holotype was collected at the type locality in October, 1921, by W. M. Mann.

The holotype is in my collection.

Xyleborus bicornatulus, n. sp.

This species is allied to *reconditus* Schedl, but it is easily distinguished by the very different sculpture of the declivity. This species has the row of tubercles on interspace 3 interrupted on the lower half, with the tubercle near the middle of the declivity much longer; the tubercles on interspaces 4-6 are also larger than in *reconditus*.

Female.— Length 2.2 mm. (female paratypes 2.0-2.8 mm.), 2.8 times as long as wide; color almost black.

Frons broadly, transversely convex, longitudinally straight to well above eyes, the epistoma slightly, gradually raised; surface reticulate, with rather coarse, deep, sparse punctures; vestiture inconspicuous except along epistoma. Eye finely faceted; half divided by a narrow emargination.

Pronotum 1.2 times as long as wide; widest just behind middle, sides weakly arcuate, feebly if at all converging before the rather abrupt anterolateral angles, rather broadly rounded in front; anterior margin subserrate; summit at middle; posterior area smooth and shining on disc, reticulate laterally, with sparse, very fine punctures; vestiture sparse, inconspicuous.

Elytra 1.6 times as long as wide, 1.3 times as long as pronotum; sides almost straight and parallel on basal two-thirds, then broadly rounded, almost straight on median third of posterior margin, the arcuate portion strongly serrate; striae not impressed, the punctures very small, distinct; interstriae shining, not entirely smooth, about four or five times as wide as striae, the punctures about as small as those of striae. Declivity beginning very slightly more than one-third the elytral length from base, gradual, rather broadly excavated, the sides moderately elevated, rounded; striae 1 and 2 wider than normal, distinctly punctured; interspaces 1 and 2 shining and uniseriately punctured, each with three or four tubercles at declivital base, 1 weakly elevated, 2 impressed; interspace 3 somewhat elevated, upper third armed by a row of up to five tubercles, an additional much longer spine at middle of declivity; apex of interspace 3 near declivital margin with one or two tubercles; interspace 4 with a row of rather coarse, pointed tubercles on upper third, 5 with a similar series on middle half, 6 and 7 with similar series on most of lower half, a few tubercles extending almost to apex. Vestiture consisting of rows of interstrial hair, rather fine on disc and sides, stout on declivity.

Male.— Not represented in the material at hand.

Type Locality.—Moravia, Cartago Prov., Costa Rica.

Hosts.— *Ochroma* sp., and *Theobroma cacao* (paratypes).

Type Material.— The female holotype and 21 paratypes were taken at the type locality on March 11, 1964, at an elevation of about 500 m., by S. L. Wood, from an unknown log. Additional paratypes were taken in Costa Rica as follows: 15 at Finca La Lola, Limon, Prov., December 27, 1962, J. L. Saunders; 1 at Rio Damitas in the Dota Mountains, San Jose Prov., Feb. 18, 1964, 250 m ; 3 Finca Gromaco on Rio Coto Brus, Puntarenas Prov., July 14, 1963, 500 m. One paratype was taken 12 km. southeast of El Hato del Volcan, Chiriqui, Panama, January 7, 1964, 1,000 m.; and 5 paratypes were taken at Pamplona. San Vicente, Santander, Colombia, on June 26, 1959, by S. Betancourt, from balsa.

Corthylus splendens, n. sp.

This species is very closely related to *collaris* Blandford and possibly could be a subspecies. It differs from *collaris* by the shorter frontal pubescence on the female, by the much smaller cirrus on the female antennal club, by the shining, more finely punctured elytra, and by the more shallowly, more narrowly impressed elytral declivity.

Female.— Length 2.0 mm. (paratypes 1.8-2.1 mm.), 2.3 times as long as wide; color yellowish to reddish brown, the elytra slightly darker (variable in series; elytra black in some paratypes).

Frons rather shallowly concave from eye to eye, from epistoma to vertex well above upper level of eyes, all margins rounded except lower lateral margins abrupt; surface of concavity evidently minutely subgranulose, obscured by abundant, erect, uniformly distributed, short hair of uniform length. Eye large, very coarsely faceted; deeply emarginate. Antennal club large, asymmetrically produced anteriorly as in *collaris*, with sutures 1 and 2 indicated by grooves; cirrus present along distal margin, scanty, not extending beyond apex.

Pronotum 1.0 times as long as wide; sides almost straight and parallel on about basal half, anterolateral angles rather abrupt, somewhat narrowly rounded in front; anterior margin armed by about a dozen low, irregular teeth; anterior area asperate to indefinite summit at middle; posterior area reticulate, subshining, punctures not evident; vestiture inconspicuous, confined to anterior and lateral marginal areas.

Elytra 1.2 times as long as wide, 1.2 times as long as pronotum; sides very slightly arcuate, not converging behind before declivital base, rather broadly rounded behind; elytral disc smooth, shining, with a few lines, the punctures minute, shallow, distinct, sparse, those on striae almost in identifiable rows. Declivity convex, rather steep, very slightly impressed on upper half toward interspace 2; interspace 1 convex, slightly elevated, striae 1 and interspace 2 (medially) impressed, gradually ascending laterally to interspace 3; punctures of striae 1 moderately large, in rows, those on 2 small, almost entirely obsolete, others not discernible; some punctures of

interspaces 3 evident. A few, fine, hairlike setae present on sides and lower declivity.

Male.— Similar to female except frons convex, with a conspicuous, transverse impression just above epistoma, very coarsely, deeply, sparsely punctured, glabrous; pronotum more narrowly rounded in front and armed by only two large, pointed teeth.

Type Locality.— Sixteen km. southeast of Cartago on the Pan-American Highway, Cartago Prov., Costa Rica.

Hosts.— *Miconia globuliflora* (type), *M. dodecandra*, *Conostegia oerstediana*, *Phoebe mexicana*, *Solanum torvum*, *Theobroma cacao*, and several other woody plants.

Type Material.— The female holotype, male allotype, and 37 paratypes were collected at the type locality on September 24, 1964, at an elevation of 1,800 m., by S. L. Wood, from branches of the above *Miconia*. Other paratypes were taken in Costa Rica, in 1963, by me, as follows: 6 at the type locality, July 3; 2 at Peralta, March 10, 1964, 500 m.; 11 on July 2 and 13 and on Oct. 24 at Tapanti at 1,300 m.; and 1 at Turrialba on July 5, 700 m., Cartago Prov.; 8 at San Ignacio de Acosta, San Jose Prov., on July 5, 1,500 m.; 14 at Pandora, Limon Prov., on July 23, 50 m.; and 1 at Volcan, Puntarenas Prov., December 11, 700 m. Ten paratypes were taken December 27, 1962, and 2 in July, 1963, at Finca La Lola, Limon Prov., Costa Rica, by J. L. Saunders; and 4 at 12 km. southeast of El Hato del Volcan, Chiriqui Prov., Panama, on January 7, 1964, 1,000 m., by S. L. Wood.

The holotype, allotype, and paratypes are in my collection.

Tricolus saundersi, n. sp.

This species is in the same species group as *nodifer* Blandford, but it is smaller, reddish brown in color, and has the lateral profile of the third declivital tooth more nearly quadrate.

Male.— Length 2.3 mm. (paratypes 2.3-2.6 mm.), 2.8 times as long as wide; color reddish brown.

Frons broadly convex, the surface rather finely reticulate and finely punctured, with a large, transversely oval, slightly elevated, coarsely reticulate area occupying central half, its upper limits slightly above upper level of eyes; vestiture limited to epistomal margin. Antennal funicle three-segmented; club broadly obovate, suture 1 weakly, 2 moderately procurved, both sutures partly septate.

Pronotum 1.4 times as long as wide; widest near base, sides almost straight, almost imperceptibly converging anteriorly on basal half, then very narrowly, almost subangulately rounded in front; anterior margin armed by a series of about a dozen teeth, the median one larger and projecting more nearly forward; asperities decreasing in height posteriorly, appearing a short distance behind summit as shining wrinkles; posterior areas reticulate, very finely, sparsely punctured; glabrous.

Elytra 1.5 times as long as wide, 1.6 times as long as pronotum; sides almost straight and subparallel to base of declivity then arcuately narrowed about a fourth to the projecting third declivital teeth, very broadly, shallowly emarginate behind; surface almost smooth, shining, the punctures rather fine, not close, strial and interstrial punctures not close, in obscure rows except confused near suture. Declivity abrupt, broadly excavated, the lateral and upper margins abruptly elevated; upper margin bearing a small, acute tooth as tall as wide, in line with striae 1, the second tooth located on lateral elevation just above middle of declivity, subquadrate, about one and one-half times as long as basal thickness, projecting caudad and slightly dorsad; teeth 1 and 2 connected by an acutely margined ridge thicker than high; tooth 3 just above and basally separated from the acutely marked posterior declivital margin, subquadrate, with upper basal margin expanded, twice as thick and almost twice as long as 2, directed primarily caudad but slightly inward and upward; ridge connecting 2 and 3 thicker than above, but with the same continuous acute inner margin that ends in 3; excavation broadly, transversely concave. the suture slightly elevated, the punctures rather fine, shallow, not sharply defined, confused. Glabrous.

Female.— Similar to male except posterior face of antennal club bearing several scattered, long hairs.

Type Locality.— Dominical, Puntarenas Prov., Costa Rica.

Host.— *Theobroma cacao.*

Type Material.— The male holotype, female allotype, and 4 paratypes were collected at the type locality on September 29, 1964, near sea level, by J. L. Saunders, from a branch of cacao.

The holotype, allotype, and paratypes are in my collection.

Tricolus spectibilis, n. sp.

This species is very closely related to *speciosus* Schedl from which it is distinguished by the more strongly projecting second declivital spine which is horizontal on its upper, distal half.

Female.— Length 2.4 mm. (paratypes 2.3-2 5 mm.), evidently 3.0 times as long as wide (elytra slightly spread); color very dark brown.

Frons not visible, head withdrawn into prothorax in all specimens except allotype, evidently as in male, described below.

Pronotum 1.3 times as long as wide; sides subparallel but feebly arcuate on basal half then convergently arcuate to the narrowly rounded, subserrate, anterior margin; asperities decreasing in size posteriorly, ending at or before summit; posterior area subreticulate, finely, deeply, rather sparsely punctured; glabrous.

Elytra 1.7 times as long as wide, 1.3 times as long as pronotum; sides almost straight and parallel to level of middle of declivity, then very broadly rounded behind, with a rather broad, deep, sutural

emargination; strial punctures fine, shallow, in rather indefinite rows; interstriae smooth, with a few irregularly placed punctures identical to those of striae. Declivity beginning two-thirds elytral length from base, broadly, deeply excavated, with upper and lateral margins acutely, rather strongly elevated except rounded on interspace 1; upper margin armed on interspace 2 by a small, pointed tooth; a second prominence on lateral margin just below middle, its basal margins in lateral profile form a 90 degree angle (somewhat blunt); the acute margin continuing to apex; profile as in *speciosus* except the second prominence higher; excavated area broadly concave, shining, sutural interspace finely, not strongly elevated, smooth, the remaining area finely, rather closely punctured. Glabrous.

Male.— Similar to female except serrations on anterior margin of pronotum much more prominent. Frons rather strongly, broadly convex; surface reticulate and rather coarsely, deeply punctured except on a small, more coarsely reticulate, impunctate area below upper level of eyes equal in diameter to one-fifth width of frons; vestiture limited to epistomal area.

Type Locality.— Finca La Lola, Limon Prov., Costa Rica.

Host.— *Theobroma cacao.*

Type Material.— The female holotype, male allotype, and four paratypes were collected at the type locality on June 22, 1963, by J. L. Saunders, collection number 53.

The holotype, allotype, and paratypes are in my collection.

ON THE EARTHWORM FAUNA OF THE GREAT AMERICAN DESERT AND ADJACENT AREAS[1]

G. E. Gates[2]

The Great American Desert, in long gone days when grade school geography texts were large enough to conceal sundry surreptitious activities from Teacher, was a conspicuous feature on American maps. Little is heard today about that desert and a hasty glance through the present, smaller-sized texts suggests that the region may have lost much of its significance even if it has not entirely disappeared. Deserts usually are not associated mentally with soft-bodied, moisture-loving animals such as earthworms. Nevertheless, some Asiatic, desert-like regions have large populations. Very little information has been available hitherto about the earthworms of the Great Basin and adjacent states. Fortunately, Prof. D E. Beck was interested in this problem and for a number of years collected oligochaetes as opportunity offered. Now that he is no longer able to continue that activity he has interested a former student and colleague, Prof. T. W. Barrett in carrying on the project.

No attempt is made to specify an exact boundary for the region under consideration herein. All of it does have one character in common which will become obvious as this contribution is read. Of California only the arid southern region is included. A small portion of the northwest corner of Idaho is excluded for reasons stated below. Some data about states, for which no specimens were available, are summarized (*cf.* appendix) to complete a review of available evidence pertinent to the problems under consideration.

The introduction originally was as above but the manuscript was not for a time submitted for publication because of anticipated objections to the title and the frequent use of "desert" in the text. Then Hollon's book (1966) was encountered. According to that author, the existence of a great American Desert is a fact that must not be concealed or deprecated. Rather, it should be fully acknowledged, with pride for past achievement in difficult circumstances and with justified hope for future control insofar as available water permits. The approximate limit of desert influence, as shown in Hollon's frontispiece map, encloses most of the region herein discussed. Although not because of inadequate rainfall, Minnesota, Iowa and Missouri are included for reasons explained below.

1. From research financed by the National Science Foundation.

2. Department of Zoology, University of Maine, Orono.

ACANTHODRILIDAE

Microscolex Rosa, 1877

Microscolex dubius (Fletcher, 1887)

CALIFORNIA.— San Diego Co.: Alpine, 1836 feet, bottom of canyon, relatively undisturbed area east of city on Route 80, moist humus type of soil at stream bank, March 10, 1966, 0-0-5. Beck; Santa Barbara Co.: Santa Barbara, 2 miles south of city limits, highly granular sand covered with about a quarter inch of humus of stream bank, under Pacific Coast Highway, March 25, 1966, 0-0-2. Beck.

ARIZONA.— Maricopa Co.: Mesa, March 6, 1966, 0-0-5 and 2-0-17. T. Barrett and D E. Beck. Wickenburg, March 8, 1966, along banks of Hassayampa River, March 8, 1966, 0-0-1. Beck.

REMARKS.— *M. dubius* had been reported previously from California but like other earthworm species only from a northern part of the state.

Reproduction is parthenogenetic.

Microscolex phosphoreus (Duges, 1937)?

ARIZONA.— Luminescent specimens (alive) secured by Barrett were considerably damaged during transportation. The spermathecae were like those of *M. phosphoreus*. No other species of the United States is known, at present, to have those two characteristics along with an appropriate size. There is no previous record of the species from Arizona. An older record of *phosphoreus* is for Santa Barbara County, California.

REMARKS.— Reproduction in *phosphoreus* probably is parthenogenetic. Both species of *Microscolex* are widely distributed anthropochores, probably originally from southern South America, certainly exotic anywhere in North America.

LUMBRICIDAE

Allolobophora Eisen, 1874

Allolobophora chlorotica (Savigny, 1826)

CALIFORNIA.— This species was first recorded from California nearly ninety years ago as *riparia*. Less than a quarter of a century later it was simultaneously recorded from 29 places in the state. That presumably was the basis for a subsequent erroneous characterization (Michaelsen, 1900) of the distribution as "ganz Nord-Amerika." Actually to this date, the species has only been reported from about a score of the 49 mainland states and but five of the Canadian provinces.

The species is not now expected to be common in southern California.

Reproduction is obligatorily biparental.

Idaho.— Idaho Falls, September 2, 1952, 5-16-3. Beck; Canyon Co.: Middleton, from sod below surface of Boise River one mile south of the town, June 19, 1964, 0-0-5. Beck; Clark Co.: Birch Creek, at 6500 feet, about 15 miles south of Lemhi County border, from turf under birch, willow and an occasional quaking aspen, June 3, 1952, 1-2-14. Beck; Lemhi Co.: Salmon, 11 miles to the north, *ca.* 4100 feet, from fibrous root system of grassy turf of a relatively dry meadow near Salmon River, June 1, 1952, 2-3-8. Beck, Mary Clark, Grace Grant.

Remarks.—*Megascolides americanus* Smith, 1897, of course was the first species to be recorded from within the present political limits of Idaho. The worms were found just east of the Washington border near Pullman. The latter is presumed to be the type locality. The presence of *M. americanus* in Latah County, if not a result of transportation, puts the place where it was found into a Pacific zoogeographic region and thereby removes it, as already mentioned above, from the area under consideration herein.

The records above are the first of an identified megadrile species for a very large unexcluded portion of Idaho. That state is one of those in which Seton (1904 or 1929 summarizing 19th century observations and records) himself could find no earthworms. However, long ago Wilcox (1884) reported that "At Boise City, Idaho, some enthusiastic disciples of Izaak Walton imported and successfully reared the coveted bait in soil suited to the habitat of the Lumbricidae!" The species is unlikely to have been *chlorotica* but certainly does not need to be *L. terrestris* (*q. v.* below) as some are likely to think. The introduction was made, according to Wilcox, because there were no "angleworms" in prairies of the "Northwest."

European settlement began in 1860. Some years probably passed before angleworms were first introduced.

Nevada.— Elko Co.: Ferguson Springs, ca. 25 miles south of Wendover (Utah) on Route 50, under boards and rocks along edge of drain where seep water from the spring coursed down the hillside. August 5, 1950, 0-0-1. Beck ("Surrounding country extreme desert.") Lyon Co.: Wabuska, July 5, 1966, 4-6-28. Carson River, south of Silver Spring, July 15, 1966, 0-1-1. E. V. Komarek, Sr.; Washoe Co.: Wadsworth, damp porous soil associated with root system of rank plant growth some distance from edge of the Trukee River, August 6, 1950, 0-0-13. Beck.

Remarks.— These are the first records of earthworms for Nevada. For reasons now unknown, neither Seton (1929) nor Wilcox (1884) mention Nevada although it already had been cut off from Utah as a separate territory in 1861.

Utah.— Sanpete Co.: Mt. Pleasant, Pleasant Creek Picnic Grounds, at contact line of conifers and aspens, August 5, 1951, 0-0-8. Beck; Summit Co.: Wanship, at 5900 feet, about two feet above stream bed, six inches under sod kept moist by ephemeral

seepage, July 13, 1962, 0-1-2. Beck; Uintah Co.: Vernal, soil by a roadside creek, August 27, 1952, 0-0-1. Beck; Utah Co.: Soldier Summit, upper three inches of heavy clay under cardboard and wooden boxes of an abandoned garbage dump, May 22, 1952, 1-2-10. Provo, April 12, 1951, 0-0-3. Beck; Washington Co.: Pine Valley, July 16, 1953, 0-0-3. Zion National Park, detritus and under stones along one of the side streams near Weeping Rock, Virgin River, September 3, 1950, 0-1-1. Beck.

Remarks.— The records above are the first for Utah of an identified species. However, earthworms probably have been there for at least a century. Provo, Utah, according to Hallock, (1877, p. 353), "is the only place west of the Rocky Mountains where an abundance of earthworms may be had, the species having been introduced by an enterprising physician from the east."

The introduced worms are unlikely to have been of *chlorotica*, as anglers, for several centuries, have deemed them useless as fish-bait. *Lumbricus terrestris* probably was believed, by the enterprising physician, to be his species, but one, or more, of the allolobophoras is much more likely.

Arizona.— Mohave Co.: Cane beds, under rocks in sandy soil with little humus by a trough at which cattle drink, from an area no "more than a yard square," July 1, 1953, 0-1-17. Beck; Yavapai Co.: Prescott, March 7, 1966, 0-6-14. Beck.

Remarks.— *A. chlorotica* had not been recorded hitherto from Arizona, one of the states in which Seton (1929) failed to find earthworms.

Montana.— Mineral Co.: Saltese, 3 miles east of Lookout Pass on Route 10, at about 4000 feet, mucky black forest soil near a small stream and/or a coarse sand and gravel mixture by the stream side, June 25, 1954, 0-0-4. Beck.

Remarks.— This is the first record of an earthworm species for the large state of Montana. Seton (1929) found no earthworms there.

Colorado.— Routt Co.: Along the Yanipa River, *ca.* 2 miles north of Steamboat Springs, under stones, boards, logs and in loose soil near willow clumps in a small meadow, August 27, 1952, 0-0-8. Beck.

Remarks.— This species was recorded from Colorado once before (Smith, 1917) but without specification as to county or town.

In his Colorado searches, Seton (1929) found no earthworms.

Further evidence as to former absence in the state was provided by Cockerell (1924):

"In the mountain district of Colorado, and the adjacent upland plains, it appears that earthworms were formerly absent. Old settlers assure us that when they first came there were none. This seemed at first almost incredible, but in recent years Prof. Frank Smith of the University of Illinois has collected earthworms in Colorado, and found only the widespread presumably introduced types." (*cf.* Smith, 1917)

Cockerell is but one of the very many biologists who have thought the facts to be "almost incredible."

Allolobophora longa Ude, 1885

Colorado.— Chaffee Co.: Buena Vista, Rancho Sawatch, August 14, 1953, 0-1-0. Ottys Sanders.

Remarks.— This is the first record of this species for any place west of the Mississippi River.

Allolobophora trapezoides (Duges, 1828)

California.— Imperial Co.: Holtville, bank of Alamo River west of town, March 9, 1966, 0-0-2. Beck; Kern Co.: Wasco, residence of P. D. Pilsbury, dark wet earth under a hedge around outlet of an air-conditioning hose, August 21, 1950, 4-2-2. Beck. With fibrous root system of Bermuda grass at edge of a stagnant pool in an irrigation ditch, August 21, 1950, 0-1-4-6. P. D. Pilsbury per Beck; Los Angeles Co.: Torrance, six inches of moist organic soil above sand in a flower bed, August 29, 1950, 5-1-1. Beck. Foothills of Angeles Mountains, at *ca.* 1500 feet, December 31, 0-4-8. D. McKey-Fender. Orange Co.: Capistrano, one mile north in ditch by highway, December 29, 0-0-4. D. McKey-Fender. San Bernardino Co.: Victorville, one half mile west of bridge over Mohave River, in wet, coarse sand under algal compost, September 1, 1950, 0-0-3. Beck. Santa Barbara Co.: Santa Barbara, two miles south of city limits on Pacific Coast Highway, very moist, highly granular sand covered with about a quarter inch of humus on bank of stream under highway, March 25, 1966, 0-0-1. Beck. San Diego Co.: Pine Valley, June 21, 1966, 0-0-10. E. V. Komarek, Sr. Alpine, bottom of a shallow canyon, at east entrance to city on Route 80, moist humus soil on banks of small stream. March 10, 1966, 12-9-19. Beck (nine cocoons secured at this site may have been deposited by *A. trapezoides*).

Remarks.— A deep brown allolobophora, so common at moist or swampy places in California, was mentioned by Eisen in several of his pre-1900 contributions. The species must have been lacking in Scandinavia or he would have had a name for it. Indeed, because of that unfamiliarity he seems at times to have suspected that the species might be native. Much more recently and with much less justification *L. rubellus* has been believed to be native to Washington State merely because of its commonness there.

The two anthropochorous allolobophoras, often correctly characterized as deep brown, are *A. longa* and *trapezoides*. Neither had reached Scandinavia by 1900. Since then *A. trapezoides* has been secured in a northern part of California and once, rather surprisingly, at a height of 5800 feet. No evidence indicative of any California colonization by *longa* has been found. *A. trapezoides* now seems to be originally from a Mediterranean source. As such, the

species could have been introduced at an early date by Spaniards who established 21 missions from San Diego to Sonoma during 1769-1823. The vehicle of transport could have been earth with wine-grape plants which were taken to most if not all of the missions.

Absence of earthworms in middle and southern California also was mentioned in some of Eisen's publications. Seton (1929) found none in the mountains and the dry parts.

Reproduction, in *A. trapezoides*, is parthenogenetic. However in a sperm-maturing, Italian morph embryonic development does not begin until it is initiated by penetration of sperm into the ovum (pseudogamy). Polyploidy (*cf.* Muldal, Omodeo, 1952) has been reported.

IDAHO.— Bannock Co.: McCammon, 3 inches below surface and in an area *ca.* 2 feet square, a few feet from bank of Portneuf River and about a foot above water level,May 30, 1952, 0-1-8. Beck. Butte Co.: Arco, to the south about 1 mile, heavy black clay loam at water's edge and a more loose and only slightly moist soil a few feet above the water's edge, May 31, 1952, 0-2-19. Beck, Mary Clark, Grace Grant. Canyon Co.: Middleton, four inches below surface of an area with sod where logs and other detritus had accumulated near Boise River, June 19, 1954, 0-3-11. Beck. (Some of the worms secured at that site were said to be "balled" and presumably were in diapause. Two couples were copulating and they may have been of the amphimictic species found at the same site, though male sterile individuals do sometimes still copulate with each other. Cocoons were deeper down and in sandy soil.) Fremont Co.: "Osborne Springs," 25 miles north of Ashton on Route 91, in heavy black loam, 6-8 inches below surface and under a thick grass turf but ground dry at surface, September 1, 1952, 0-0-0-6. Beck (The collector stated that the worms were in the process of "balling up.") Kootenai Co.: Worley, upper three inches of soil in grassy woodland area close by a stream, June 24, 1954, 0-1-18. Beck. Latah Co.: Moscow, eight miles to the south, in area surrounding drain-off from cesspool, May 20, 1950, 0-0-1. C. W. Lame. Lemhi Co.: Salmon, hillside seep spring area, on route 93, 1 mile north of town, May 31, 1952, 0-3-16. Beck. 11 miles to the north, *ca.* 4100 feet, from fibrous root system of grassy turf of a relatively dry meadow near Salmon River, June 1, 1952, 0-4-11. Beck, Mary Clark, Grace Grant. Lincoln Co.: Shoshone Falls. Porous black soil, under rocks in shaded grassy areas, near the "Falls" area, June 18, 1954, (10?)-4-12-1. Wet to mucky sites near a spring that is the water supply for the public, June 18, 1954, 0-0-4. Sandy area beneath a west facing cliff, June 19, 1954, 0-1-3. Beck.

REMARKS.— *A. trapezoides* is the second oligochaete species to be recorded herein for the first time from Idaho. In that area Seton (1929) found no earthworms. His conclusion as to absence was supported by Wilcox (1884). *A. trapezoides* is more likely to have been imported to Idaho in the 1880's than *L. terrestris* which at that

time probably had nowhere near reached its present and still limited American range.

Nevada.— Elko Co.: Ferguson Springs, on Highway 50, under boards and rocks along edge of drain channel where seep water from the spring coursed down the hillside, surrounding country extreme desert, August 5, 1950, 1-3-5. Beck. Lyon Co.: Wabuska, July 5, 1966, 1-1-0. E. V. Komarek, Sr. Washoe Co.: Wadsworth, from damp, porous soil associated with root system of rank plant growth some distances from edge of the Trukee River, August 6, 1950, 0-3-11. Beck.

Remarks.— *A trapezoides* is the second earthworm species to be recorded herein for the first time from Nevada. Although this state was not mentioned by Seton (1929) he obviously believed (*cf.* p. 144) its earthworm fauna to be the same as that of other desert states.

European settlement began around 1849.

Utah.— Beaver Co.: Beaver, soil of a peat-like consistency near a small stream, July 11, 1952, 0-1-13. Marvin Coffey per Beck. Wahwah Springs. Moist soil along stream bank, in a marshy soil and under rocks near the marshy area, September 12, 1952, 8-2-0. Highly organic soil and under rocks near edge of desert spring and its runoff. September 12, 1950, 1(+24?)-4-5-1. Beck. Box Elder Co.: Lucin, seven miles to the north at a desert spring where water was salty and vegetation was of the alkaline desert type, June 19, 1952 0-0-3. Beck. Daggett Co.: Willow Creek, at 6000 feet, under plant cover of sage and juniper, near Uintah Mountains, June 12, 1953 0-0-11. Beck. Garfield Co.: Bear Valley Junction (probably August 1952?), 4-4-0. M. A. Coffey per Beck. Iron Co.: Cedar Breaks National Monument, June 20, 1953, 3-6-20-2. Beck. Juab Co.: Levan 8 miles to the south on Route 28, 3-6 inches below surface, under stones and boards in an area about two yards square, April 19, 1952 1 (+?)-20-13-11. Beck. (The area is extremely dry in the summer snow had covered the ground 10 days before the collection.) Piute Co.: Marysvale, 2 miles south of Big Rock Candy Mountain on Route 89, with fibrous root system of grass and sedge quite close to water level in Sevier River, June 26, 1952, 1-0-10. Beck. Rich Co.: Sage Creek Junction, bank of a creek, with wet soil and fibrous roots, at 6500 feet. August 21, 1952, 0-3-14. Woodruff, at the edge of marshland seven miles west and in the confines of a canyon mouth at 7000 feet, six inches below surface in very porous and moist soil June 25, 1953, 0-2-4. Beck. San Juan Co.: Kigalia Ranger Station Bears Ears, in black soil near stream at 8500 feet, June 8, 1955 0-5-22-9 and June 9, 1955, 0-0-2. Bluff, May 5, 1951, 0-1-4. Beck Sanpete Co.: Mt. Pleasant, Pleasant Creek Picnic Grounds, beneath bark and under trees fallen to the ground, August 5, 1951, 3-3-1. Beck. Summit Co.: Wanship, at 5900 feet, about two feet above stream bed, six inches under sod kept moist by ephemeral seepage July 13, 1962, 0-1-1. Echo, July 11, 1952, 0-0-2. Beck. Utah Co. Soldier Summit, upper three inches of heavy clay under cardboar

and wooden boxes of an abandoned garbage dump, May 22, 1952, 16-6-2. (Late juveniles had rudiments of genital tumescences in clitellar region but none were recognizable in ix-xi. Tubercula pubertatis unrecognizable.) Lehi. Lehi Sugar Factory area, in wood of a rotted board near pond, April 25, 1952, 1-0-0. Beck. (Elsewhere in the area no worms were found.) Weber Co.: Ogden, depressions in the flood plain plant growth is rank, September 3, 1952, 5(+?)-5 (+?)-0. Beck. Washington Co.: Grafton, upper 8 inches of heavy, sandy, dark-colored loam, under rocks, boards, and logs in an orchard April 5, 1952, 3-3-26. Beaver Dam Wash, Ed Terry Ranch, 3-10 inches below ground surface but under gopher mounds, in alfalfa field, at *ca.* 2500 feet, in the joshua tree-creosote belt, February 23, 1952, 0-17-6. St. George or Springdale, September 2, or September 3, 1950, 0-0-1-2. Pine Valley, July 16, 1963, 0-1-14. Leeds, Oakgrove Campground, at 700 feet, mucky soil along a seep stream, July 14, 1953, (?)-2-4. Zion National Park, in detritus and under stones along one of side streams near Weeping Rock, Virgin River, September 3, 1950, 0-2-2. Beck. Wayne Co.: Elkhorn Ranger Station, Thousand Lake Mt., at 9700 feet, damp, loose black soil under rocks and dead timber, and in a forest of quaking aspen, *Populus tremuloides*, August 9, 1952, 3-2-10. Beck.

Remarks.— *A. trapezoides* is the second species to be recorded herein for the first time from the state of Utah.

The original home of the taxon probably is in some part of the Mediterranean region. Professor Beck was asked to provide information as to how a Mediterranean earthworm could have been brought to Utah. He replied (*in lit.*) that he believed some stock of fruit trees came along with the first settlers as an agricultural program had been worked out even before Mormons left Nauvoo. Arrival in Utah was between 1847 and 1850. So plants started to arrive and were well in growth soon after 1847 and began to be spread by colonization north, south, east and west. Beck, speaking of the history of the settlement of St. George with which he is well acquainted, stated (*in lit.*, Jan. 5, 1965): "Joseph E. Johnson, an early leader in horticulture in southwestern Utah, imported many fruit trees right after settlement. These came by horseback, wagon, buggy, and carried by hand; some from California and others from northern Utah. This was between 1861 and 1870. Within that period the people had no fruit, to a condition of abundance: Peaches, plums, pears, apples, figs, nectarines, almonds, quince, raspberries, strawberries, pomegranates, and apricots. One time he imported 1,000 maple trees hoping to develop the maple sugar industry in southern Utah." Plants presumably were brought across the plains from Mississippi or from Los Angeles by way of the San Bernardino Pass. If winegrape plants were imported from Los Angeles the dark brown allolobophora that was so common in California could have been brought to Utah directly. Another possibility is that the species also could have come along with plants from southern states or even a southern part of Illinois.

Arizona.— Cochise Co.: Alfalfa field, 4 miles north of Elfrieda and *ca.* 25 miles north of Douglas, upper two inches of sandy loam with perhaps 2½% organic matter, September 3, 1966, 18-1-1-15. Leslie Canyon, McNeal, upper four inches of sandy to clay loam with 2-3% organic content, along a small stream (no fishing), under Arizona willow, September 3, 1966, 1-2-3-1. 16 miles northeast of Douglas Canyon-Ricker Road, ¼ mile east of road near cattle pen at 4600 feet, from sod and upper 4 inches of black, heavy, clay loam nearly saturated by four days of rain (no farms and permanent streams in the area), September 16, 1966, 8-1-21. 3 miles south of Junction of Leslie Canyon and main east-west Rucker Canyon road, among roots in top four inches of loam by abandoned water storage tank (for cattle, no fishing streams nearby), September 16, 1966, 5-3-6. Barrett per Beck. Tombstone, Costello Ranch, 8 miles from town at elevation of *ca.* 5000 feet, in soil rich with manure (pH *ca.* 7.5), July 23, 1933, 0-2-6 also 2 fragments, each containing a clitellum. A. Petrunkevich per G. E. Pickford.

Gila Co.: Sierra Ancha Exp. Forest Headquarters. Two miles north of Headquarters, along almost dry Rose Creek, in sandy loam under walnut and oak, August 29, 1966, 0-0-0-9. Ten miles north of headquarters, at confluence of Rose and Workman Creeks, top four inches of sandy-clay loam at edge of meadow, under walnut, sycamore and Arizona willow, at 6200 feet, August 29, 1966, 11-4-0-1. Top 2 inches of loam to sandy loam under or near maple (but not pine and fir), within 10 feet of bank on each side of Workman Creek (but lacking 10-50 feet from the bank), at 6900 feet, August 30, 1966, 6-2-3. A dell under a maple, 3 miles up Workman Creek from Young Road, at *ca.* 6500 feet, sandy loam with maple leaves and grass, September 1, 1966, 9-3-6-3. Barrett per Beck. Mohave Co.: Cane beds, under rocks in sandy soil with little humus by a trough at which cattle drink, July 11, 1958, 0-1-8. Beck.

Remarks.— *A. trapezoides* probably was the member of the *caliginosa* congeries that was recorded from Arizona 67 years ago. Recent collections from the state have contained only one lot of *turgida* and none of *tuberculata*. A very abnormal Tombstone specimen, at first tentatively referred to *caliginosa* (Gates, 1956), enabled synonymization of the supposedly Lusitanian and very old *A. relictus* Souther, 1909, without examination of the type (the only known specimen). The homoeosis of both worms was maximal.

Arizona is one of the states in which Seton (1929) found no earthworms. It is unlikely that he searched in gardens or sites to which the animals could have been deliberately or accidentally introduced.

Montana.— Ravalli Co.: Hamilton, four miles west and near Blodgett Creek at 3600 feet, upper 3-4 inches of black soil mixed with sand under *Pinus ponderosa*, June 1, 1952, 1(+1?)-2-18. Black, heavy loam under coarse sandy soil near bank of Bitterroot River, June 1, 1952, 0-3-2. Beck, Mary Clark, Grace Grant. Victor, moun-

tain meadow stream rising in the Bitterroot Mountains, June 25, 1954, 0-0-6-1. Beck.

Remarks.— No species of earthworm had been reported from Montana before. The state is one of those in which Seton (1929) found no earthworms.

The earliest European settlers, after traders, trappers and explorers, were miners. Farming is said to have been little till after 1880.

Wyoming.— Hot Springs Co.: Wilderness, 20 miles south of Dubois, along bank of Deniwoodie River where it crosses Route 287, under short grass turf at edge of stream, August 30, 1952 (2?)-26-5. Beck. Teton Co.: Teton National Park, about 5 miles north of the park boundary where Snake River crosses Route 287, sodded bank of river (where bait had been dumped at end of day's fishing?), August 31, 1952 (4?)-9-3-1. Beck.

Remarks.— This is the first record of an identified megadrile species from the state of Wyoming. The area is mentioned as one of those in which Seton (1929) could find no earthworms.

Probably few Europeans had settled in Wyoming before 1867 when the Union Pacific began to build its railroad through the state.

Colorado.— Boulder Co.: Longmont, under log in pasture at Boulder Creek and its crossing by Route 287, August 29, 1952, 1-3-2. Beck. Grand Co.: Hot Sulphur Springs, moist loose dark soil with fibrous grass roots along bank of Colorado River about 7 miles southwest of the town, August 28, 1952, 0-0-0-2. Beck. Larimer Co.: Fort Collins, eight inches of dark, compact, sandy loam above water level in seepage area at base of South Reservoir, August 29, 1952, 0-2-2-3. Stonewall Creek, 30 miles south of Wyoming border on Route 287, loose sandy soil with much humus in sodded area where willow growth was rank, August 29, 1952, 0-15-8-2. Beck. Routt Co.: Steamboat Springs, two miles north, along edge of Yanipa River, also under stones, boards, logs, August 27, 1952, 0-1-1. Beck.

Remarks.— These are the first records of *A. trapezoides* for Colorado, a state in which Seton (1929) found no earthworms (also *cf* p. 145).

Gold was discovered in 1850 but the rush came only in 1858. Before that there probably had been little white settlement.

Iowa.— Jefferson Co.: Fairfield, Parsons College, May 22, 1951, 0-0-5. Von Ohlen.

Remarks.— *A. trapezoides* had been recorded for Iowa but as *A. iowana* Evans, 1948. A cotype from the U. S. Nat. Mus. has been examined. The Fairfield specimens mentioned above are from the type locality and were secured by the same person who collected the types of Evans' species.

Allolobophora tuberculata Eisen, 1874

California.— Santa Barbara Co.: Santa Barbara, March 25, 1966, 0-2-1. Beck.

Remarks.— *A. tuberculata* had not been recorded from California previously.

Reproduction, in *A. tuberculata*, is obligatorily biparental.

Idaho.— Canyon Co.: Middleton, four inches below surface of sod where logs and other detritus had accumulated on bank of Boise River, June 19, 1954, 0-0-3. Beck. (Worms were congregated in the humus but cocoons were in sandy soil beneath. Two pair were *in copula*. Although soil still was relatively moist, some worms were "balled." Clark Co.: Birch Creek, about 15 miles south of Lemhi County border on Route 28, from turf under birch, willow and an occasional quaking aspen, at 6500 feet, June 3, 1952, 4-3-8. "Osborne Springs," *ca.* 25 miles north of Ashton on Route 191, heavy black loam, 6-8 inches below surface, in process of "balling," surface quite dry, September 1, 1952, 1-1-3. Beck. Lemhi Co.: Salmon, 11 miles to the north, *ca.* 4100 feet, from fibrous root system of grassy turf of a relatively dry meadow near Salmon River, June 1, 1952, 0-8-11. Beck, Mary Clark, Grace Grant. One mile north, seep area of a hillside spring, 0-4-17. Beck. Morgan Co.: Weber Canyon, 6 miles east of Coalville, heavy loam with humus in shaded woodland down to depth of 8 inches, at 5600 feet, July 11, 1952, 0-1-20. Beck.

Remarks.— *A. tuberculata* is the third species to be recorded herein for the first time from Idaho.

Nevada.— White Pine Co.: Kennicot Duck Creek Station, one mile to the south, wet heavy clay soil with organic matter, August 5, 1950, 0-2-2. Beck.

Remarks.— *A. tuberculata* is the third species to be recorded herein for the first time from Nevada.

Utah.— Cache Co.: Hyrum, north fork of the Blacksmith Fork Canyon, near edge of mountain stream at 7500-8000 feet, under birch and sod, June 27, 1953, 0-5-6. Beck. (From 8-10 inches below surface, in dark compact soil. No worms in top six inches of sandy soil. Some were "balled.") Piute Co.: Kingston, bank of ditch at base of cliff in canyon desert at 6100 feet, June 26, 1-0-2. Beck. Summit Co.: Wanship, at 5900 feet, about two feet above stream bed, six inches under sod kept moist by ephemeral seepage, July 13, 1962, 0-0-1. Beck. Utah Co.: Provo, Brigham Young University campus, January 31, 1966, 0-1-0. Beck.

Remarks.— *A. tuberculata* is the third species to be recorded herein for the first time from Utah. The state was not mentioned by Seton (1929) but he obviously believed its earthworm fauna to be the same as in other desert states, *i.e.*, none.

Montana.— Mineral Co.: Saltese, 3 miles east of Lookout Pass on Route 10, at about 4000 feet, mucky black forest soil near a small stream and/or a coarse sand and gravel mixture by streamside, June 25, 1954, 0-0-2. Beck. Ravalli Co.: Hamilton, nine miles south on Route 93, bank of Bitterroot River, in black layer under sand and turf, June 1, 1952, 0-21-7. Beck, Mary Clark and Grace Grant. Vic-

tor, from grassy roots of a mountain meadow stream, June 25, 1954, 0-0-16. Beck.

Remarks.— *A tuberculata* is the third species to be recorded herein for the first time from Montana.

Wyoming.— Albany Co.: Laramie, August 29, 1952, 1-2-9. Beck. Fremont Co.: Lander, soil with humus along bank of Papaogie Creek, August 30, 1952, 0-7-1. Beck.

Remarks.— *A. tuberculata* is the second species to be recorded herein for the first time from Wyoming.

Colorado.— Chaffee Co.: Buena Vista, Rancho Sawatch, August 14, 1953, 0-0-1. Ottys Sanders. Grand Co.: Hot Sulphur Springs, under stones and in fibrous grass roots of moist, loose, dark soil with much humus along banks of Colorado River, August 28, 1952, 0-3-25. Beck. Larimer Co.: Fort Collins, seepage area at base of South Reservoir, in upper eight inches of a dark, compact, sandy loam high in humus above a wet level, August 29, 1952, 0-14-7. Beck.

Remarks.— These are the first records of *A. tuberculata* for Colorado.

New Mexico.— Grant Co.: Fort Bayard, Central City, *ca.* 6190 feet, arroyo drainage, 6 and more inches below surface, February 27, 1966, 0-0-2. Beck.

Remarks.— This is the first record of a lumbricid earthworm for the state of New Mexico.

The first permanent European settlement, by Spaniards, was in 1610.

Iowa.— Jefferson Co.: Fairfield, Parsons College, May 22, 1951, 0-3-4. F. W. Von Ohlen.

Remarks.— This is the first record of the species for Iowa. The present specimens were secured from the type locality of *A. iowana.* Evans also had specimens of *tuberculata.* He recognized that they were different from the *caliginosa* he had studied in England and that they might be of a new species. The taxon already had been provided a name by Eisen as well as by Friend and Gates, independently.

Allolobophora turgida Eisen, 1874

California.— San Diego Co.: Alpine, bottom of a shallow canyon, at east entrance to city on Route 80, moist humus soil on banks of small stream, March 10, 1966, 2-5-25. Beck. (Nine cocoons found at the site are less likely to be of *A. turgida* than *A. trapezoides.*) Santa Barbara Co.: Santa Barbara, very moist, highly granular sand covered with about a quarter inch of humus on banks of a small stream, March 25, 1966, 0-0-1. Beck. Mendocino, June 30, 1966, 1(+4?)-1-1. E. V. Komarek, Sr. (Mendocino is the only locality at which *A. turgida* is known to be present along with *A. trapezoides* and *tuberculata.*)

Remarks.— *A. turgida* had not previously been recorded from California.

Reproduction, in *A. turgida*, is obligatorily amphimictic.

Idaho.— Bannock Co.: Pocatello, roadside parking and picnic area to south on Route 91, under shubbery and boards in a very moist situation, June 3, 1952, 0-0-7. Beck. Canyon Co.: Middleton, four inches below surface of sod where logs and other detritus had accumulated on banks of the Boise River, June 19, 1954, 0-0-8. Beck. (*Cf.* note on this site, *tuberculata.*) Latah Co.: Moscow, eight miles to the south, in drain-off from a cesspool, May 20, 1950, 0-0-1. C. W. Lame. Lemhi Co.: Salmon, 11 miles to the north, *ca.* 4100 feet, from fibrous root system of grassy turf of a relatively dry meadow near Salmon River, June 1, 1952. 0-2-5. Beck, Mary Clark, Grace Grant.

Remarks.— *A turgida* is the fourth species to be recorded herein for the first time from Idaho.

Nevada.— Elko Co.: Ferguson Springs, under boards and rocks along edge of drain channel where seep water from spring coursed down the hillside, surrounding country extreme desert, August 5, 1950, 0-1-3. Beck.

Remarks.— *A. turgida* is the fourth species to be recorded herein for the first time from Nevada.

Utah.— Cache Co.: Hyrum, north fork of the Blacksmith Fork Canyon, near edge of mountain stream at 7500-8000 feet, 0-2-9. Beck. (*Cf.* note re site, p. of *tuberculata.*) Morgan Co.: Weber Canyon, 6 miles east of Coalville, heavy loam with humus in shaded woodland, down to depth of 8 inches, at 5600 feet, July 11, 1952, 0-0-2. Beck. Summit Co.: Wanship, at 5900 feet, about two feet above stream bed, six inches under sod kept moist by ephemeral seepage, July 31, 1952, 0-4-16. Beck. Wayne Co.: Elkhorn Ranger Station. Thousand Lake Mt., at 9700 feet, damp loose black soil, under rocks and dead timber, and in a forest of quaking aspen, *P. tremuloides*, August 9, 1952, 0-0-1. Fruita, wet soil near a rock-edge seep only, January 24, 1951, 0-0-2. Beck.

Remarks.— *A. turgida* is the fourth species to be recorded herein for the first time in Utah.

Arizona.— Gila Co.: Sierra Ancha Exp. Forest Headquarters. Ten miles north of headquarters, at confluence of Rose and Workman Creek, top 4 inches of sandy clay loam (with optimum moisture and an abundandce of leaf mold) at edge of meadow, under walnut, sycamore and Arizona willow, at 6200 feet, August 29, 1966. 2-11-0. Barrett.

Remarks.— *A. turgida* had not been recorded from Arizona.

Montana.— Mineral Co.: Saltese, 3 miles east of Lookout Pass on Route 10, at about 4000 feet, mucky black forest soil near a small stream and/or sand and gravel mixture by the stream side, June 25. 1954, 0-0-15. Beck.

Remarks.— *A. turgida* is the fourth species to be reported herein for the first time from Montana.

Colorado.—Routt Co.: Along the Yanipa River, *ca.* 2 miles north of Steamboat Springs, under stones, boards, logs, and in loose soil

near willow clumps in a small meadow. August 27, 1952, 0-0-1. Beck.

Remarks.— This is the first record of *A. turgida* from Colorado.

Bimastos Moore, 1893

Bimastos parvus (Eisen, 1874)

Nevada.— Lander Co.: Austin, 25 miles west on Route 50, marshland coursing through desert valley, wet organic material, August 6, 1950. 1-0-2. Beck.

Remarks.— *B. parvus* is the fifth species to be recorded herein for the first time in Nevada.

Reproduction, in *B. parvus*, is parthenogenetic and at least in male sterile morphs obligatorily so.

Wyoming.— Fremont Co.: Lander, 44 miles south, Sweetwater River crossing of Route 287, under old spruce log at sand bar, August 30, 1952. 0-0-5. Beck. Teton Co.: Moran, Teton National Park, under stones and logs, August 30, 1952, 0-0-3. Beck.

Remarks.— *B. parvus* is the third species to be recorded herein for the first time from Wyoming.

Large populations of *parvus* have not been found anywhere. Known series are short. Long thought to be native to North America, the original home of the species is unknown.

B. parvus, the only known North American anthropochore, has been carried all around the world. More than 67 years ago (Michaelsen, 1900) the species already had been intercepted at San Francsico on plants from China. A later interception (Michaelsen, 1910) was at Hamburg on plants from Japan. Recent interceptions at American ports, were from soil with plants originating in Taiwan, Japan, Australia, Mexico, England, and Italy. The species also had been found in Tibet, Afghanistan, Kazakstan, and St. Paul's Rock (uninhabited by man) in the Indian Ocean. The distribution as now known would seem to indicate that transportation of the species from this country to other continents and then back and forth around the world has been much more frequent than carriage within the United States and has resulted in many more successful colonizations.

Dendrobaena Eisen, 1874

Dendrobaena octaedra (Savingny, 1826)

Colorado.—Boulder Co.: Boulder, Bluebell Canyon, under moss near spring, September 1914. 0-0-2. (U. S. Nat. Mus.) E. J. Miller. Boulder City, June 18, 1966, 1-0-3-2. L. Krummholz & W. Osburn per Beck. Chaffee Co.: Buena Vista, Rancho Sawatch, August 14, 1953. 0-0-2. O. Sanders.

Remarks.— *D. octaedra* was recorded for Colorado once before (Smith, 1917) and from Boulder. Reproduction, in *D. octaedra*, is

parthenogenetic and at least in male sterile morphs obligatorily so. Polyploidy has been reported.

Nebraska.— Custer Co.: Custer, black soil near creek, June 29, 1946, 0-0-1. J. L. Macnab per D. McKey-Fender.

Remarks.— *D. octaedra*, previously unreported from Nebraska, is the eighth species to be recorded from that state. Others are: *A. caliginosa*, *B. parvus*, *E. foetida*, *Pheretima diffringens*, and three diplocardias of uncertain status.

Dendrobaena rubida (Savigny, 1826)

Idaho.— Butte Co.: Arco, to the south about 1 mile, heavy black clay loam at water's edge and a more loose and only slightly moist soil a few feet above the water's edge, May 31, 1952, 0-0-2. Beck, Mary Clark, Grace Grant.

Remarks.—*D. rubida* is the fifth species to be reported herein for the first time from the state of Idaho.

Reproduction, in *D. rubida*, at least for male sterile morphs is amictic. Amphimixis seems to be optional in sperm maturing morphs. Polyploidy has been reported. Only male sterile morphs were recognized in desert states.

Nevada.—Eureka Co.: Eureka, 10 miles east, 6500 feet, heavy clayey soil near a mountain spring, August 6, 1950, 0-1-8. Beck.

Remarks.— *D. rubida* is the sixth species to be reported herein for the first time from the state of Nevada.

Utah.— Box Elder Co.: Lucin, at a desert spring, seven miles to the north, where water was salty and vegetation was of the alkaline desert type, June 19, 1952, 0-0-1. Beck. Clark Co.: Birch Creek, June 3, 1952, 0-0-1. Beck. Juab Co.: Tom's Creek, Callao, moss at stream side, August 12, 1953, (18?)-0-4. Beck. San Juan Co.: Kigalia Ranger Station, Bears Ears, June 9, 1955, 4-9-3. Beck. Sanpete Co.: Mt. Pleasant, Pleasant Creek Picnic Grounds, beneath bark and under fallen trees at contact line of aspen and conifers, August 5, 1951, 0-0-9. Beck. Summit Co.: Echo, July 11, 1952, 0-0-3. Beck.

Remarks.— *D. rubida* is the fifth species to be reported herein for the first time from Utah.

Wyoming.— Fremont Co.: Wilderness, 20 miles south of Dubois, in moist soil with much humus, under short grass turf at edge of Deriwoodie River, August 30, 1952, 0-0-7. Beck. Teton Co.: Teton National Park, about 5 miles north of the park boundary where Snake River crosses Route 287, sodded bank of river (where bait had been dumped at end of day's fishing?). August 31, 1952, 0-0-1. Moran, river bank and bed about five miles to the east, August 30, 1952, 0-0-5. Beck.

Remarks.— *D. rubida* is the fourth species to be recorded herein for the first time in Wyoming.

Elsewhere, in the region now under consideration, *D. rubida* has been reported from Colorado (Smith, 1917) but under another name and without specification as to county or town.

Eisenia Malm, 1877

Eisenia foetida (Savigny, 1826)

California.— Los Angeles Co.: Temple City, March 1957. 0-4-1. P. W. Oman. San Bernardino Co.: Fontana, March 1953, 7-1-12. G. E. Templeton per E. W. Price. March 1957, 3-4-2. P. W. Oman. San Diego Co.: Jacumba. March 9, 1966, 0-8-34. Beck. (Purchased from a bait dealer who obtained them from West Virginia. In this resort city no earthworms were found in the vicinity of the hot springs, near a lake, and other spots in and around the town. Local anglers informed Beck that there are no earthworms locally.)

Remarks.— Previous Californian records of *E. foetida* were all from a northern part of the state.

Reproduction, in *E. foetida*, is obligatorily amphimictic.

Utah.— Utah Co.: Provo, April 12, 1951, 0-1-0. Beck.

Remarks.— *E. foetida* is the sixth species to be reported herein for the first time from the state of Utah.

The single specimen may have been an escapee from an artifical habitat such as the bed of an earthworm farm, a greenhouse, a potted plant, a sewage bed.

Arizona.— Maricopa Co.: Tempe, March 4, 1966, 0-0-55. Beck. (Purchased from an earthworm farm. The species was being sold for bait to produce mulch for gardens, also for introduction into wormless areas to enrich the soil.)

Remarks.— *E. foetida* had not been recorded previously from Arizona. If presence in artificial habitats such as greenhouses and earthworm farms is to be counted the species will have to be recorded from every one of the 50 states with the possible exception of Alaska, as *E. foetida*, under one or more of its popular names, has been sold for cultivation in every state and Canadian province, and was recently introduced to Hawaii. Although sold in large numbers throughout the country and transported back and forth, records for natural habitats are lacking for many states.

Eisenia rosea (Savigny, 1826)

California.— Kern Co.: Wasco, with fibrous root system of Bermuda grass at edge of a stagnant pool in an irrigation ditch, August 21, 1950. 0-0-1. P. D. Pilsbury per Beck. Los Angeles Co.: Torrance, slightly damp ground at edge of water of a marsh, August 29, 1950. 2-9-5, and 6 inches of moist organic soil above sand in a flower bed. August 29, 1950. 10-0-1. Beck. San Diego Co.: Pine Valley. June 21, 1966. 0-0-45. E. V. Komarek, Sr.

Remarks.— *E. rosea* is now reported for the first time from southern California. There are older records for a northern part of the state.

Reproduction, in *E. rosea*, is parthenogenetic and at least for the many male sterile morphs obligatorily so.

Idaho.— Bannock Co.: McCammon, 3 inches below surface and in an area *ca.* 2 feet square, a few feet from bank of Portneuf River and about a foot above water level, May 30, 1952, 0-0-3. Idaho Falls, September 2, 1952, 5-2-12. Beck. Butte Co.: Arco, to the south about 1 mile, heavy black clay loam at water's edge and a more loose and only slightly moist soil a few feet above the water's edge, May 31, 1952, 0-0-3. Mary Clark, Grace Grant and Beck.

Remarks.— *E. rosea* is the sixth species to be recorded herein for the first time from Idaho.

Nevada.— White Pine Co.: Kennicot Duck Creek Station, one mile to the south, wet, heavy, clay soil with organic matter, stream side, August 5, 1950, 2-1-6. Beck.

Remarks.—*E. rosea* is the seventh species to be recorded herein for the first time from Nevada.

Utah.— Beaver Co.: Beaver, soil of a peat-like consistency near a small stream, July 11, 1952, 1-1-0. Beck. Piute Co.: Kingston, bank of ditch at base of cliff in desert at 6100 feet, June 26, 1952, 0-2-6. Beck. Rich Co.: Sage Creek Junction, stream bank of a creek, only with wet soil and fibrous grass roots, at 6500 feet, August 21, 1952, 1-0-0. Beck. Sanpete Co.: Mt. Pleasant, August 5, 1951, 0-0-1. Beck. Summit Co.: Wanship, at 5900 feet, about two feet above stream bed, six inches under sod kept moist by ephemeral seepage, July 13, 1952, 0-1-1. Beck. Utah Co.: Soldier Summit, upper three inches of heavy clay under cardboard and wooden boxes of an abandoned garbage dump, May 22, 1952, 0-0-1. Beck. Washington Co.: St. George, almost pure clay at edge of an irrigation ditch from Virgin River, September 2, 1950, 5-0-0. Zion National Park, detritus and under stones among one of the side streams, near Weeping Rock, Virgin River, September 3, 1950, 0-2-3. Beck.

Remarks.— *E. rosea* is the seventh species to be recorded herein for the first time from Utah.

Arizona.— Cochise Co.: 16 miles northeast of Douglas on Leslie Canyon-Rucker Road, ¼ mile east of road near cattle pen at 4600 feet, from sod and upper four inches of black, heavy clay loam nearly saturated by four days of rain (no farms and permanent streams in the area), September 16, 1966, 7-0-1. Three miles south of junction of Leslie Canyon and main, east-west Rucker Canyon Road, along roots and in top four inches of sandy to gravelly clay loam by abandoned water storage tank (for cattle, no farms and fishing streams nearby), September 16, 1966, 40-1-3. Barrett per Beck. (Remote and infrequently visited areas without streams, no fishing streams near sites.) Tombstone, Costello Ranch, at elevation of *ca.* 5000 feet, in soil (pH 7.5) rich with manure, July 23, 1933, 0-0-15. A. Petrunkevitch per G. E. Pickford. Leslie Canyon, McNeal, upper four inches of sandy to clay loam along a small stream (no fishing), under Arizona Willow, September 3, 1966, 6-0-0-3. Barrett. McNeal, March 19, 1966, 2-0-0. Barrett per Beck. Coconino Co.: Payson, June 29, 1966, 4-1-3. Barrett per Beck. Gila Co.: Sierra Ancha Exp. Forest

Headquarters. Two miles north of the Headquarters along almost dry creek in sandy loam, under walnut and oak, August 29, 1966, 1-0-0. Ten miles north of Headquarters, at confluence of Rose and Workman Creeks, at edge of meadow, under walnut, sycamore and Arizona Willow, at *ca.* 6200 feet, August 29, 1966, 1-0-0-1. Top 2 inches of loam to sandy loam with 4-5% organic matter, under maple (but not pine and fir), within 10 feet of bank of Workman Creek (none in region 10 to 50 feet from bank), at 6900 feet, August 30, 1966, 2-1-0. Barrett. Maricopa Co.: Gila Bend, March 8, 1966, 8-3-0. Beck. Wickenburg, March 8, 1966, 6-1-0. Tempe, March 5, 1966, 0-14-19. Barrett and Beck. Mesa, March 6, 1966, 6-6-5-1 + one tail piece and 0-2-1. X. Frost, Beck. March 4, 1966, 0-2-1. Beck. Mohave Co.: Littlefield, rich soil with about 50% humus, under bridge on Route 91 over Beaver Dam Creek, Septemper 2, 1950, 6-5-2. Beck. (The only species secured at the site where worms "were not too numerous and required diligent searching" to find these.) Pima Co.: Tucson, June 18, 1966, -13-0 + 17 tail pieces, Beck. (At least 12 specimens were early adolescents *i.e.*, aclitellate.) June 18, 1966, 7-0-17. E. V. Komarek, Sr. Santa Clara Co.: Sondita Creek, Patagonia, June 19, 1966, 0-1-3. E. V. Komarek, Sr.

Remarks.— *E. rosea* already had been collected in the state before 1900. Nevertheless, Arizona is one of the states in which Seton (1929) said he could find no earthworms.

Spaniards could have brought live plants to their missions from some time in the early 1600's.

Montana.— Mineral Co.: Saltese, 3 miles east of Lookout Pass on Route 10, at about 4000 feet, mucky, black forest soil near a small stream or in a coarse sand and gravel mixture by the stream side, June 25, 1954, 0-0-1. Beck.

Remarks.— *E. rosea* is the fifth species to be recorded herein for the first time from Montana.

Wyoming.— Fremont Co.: Lander, soil with humus along banks of Papaogie Creek, August 30, 1952, 0-0-1. Beck.

Remarks.— *E. rosea* is the fifth species to be recorded herein for the first time from Wyoming.

Colorado.— Larimer Co.: Fort Collins, August 29, 1952, eight inches of dark, compact, sandy loam above water level in seepage area at base of South Reservoir, August 29, 1-0-10. Beck. Routt Co.: Along the Yanipa River, *ca.* 2 miles north of Steamboat Springs, under stones, boards, logs, and in loose soil near willow clumps in a small meadow, August 27, 1952, 0-0-5. Beck.

Remarks.— These are the first records of *E. rosea* for Colorado.

New Mexico.— Chaves Co.: Rio Felix, south of Dexter, February 25, 1966, 0-40-0. Beck.

Remarks.— This is the second species to be recorded herein for the first time from New Mexico. This is one of those states in which Seton (1929) himself could find no earthworms.

The first permanent white settlement was by the Spanish in 1610.

Eiseniella Michaelsen, 1900

Eiseniella tetraedra (Savigny, 1826)

California.— Kern Co.: Deep Creek, Mojave desert, April 25, 1943, 0-0-2. per D. McKey-Fender. Wasco, residence of P. D. Pilsbury, dark wet earth under a hedge and around outlet of an air-conditioning hose under a hedge, August 21, 1950, 0-0-3. Beck. With fibrous root system of Bermuda grass at edge of a stagnant pool in an irrigation ditch, August 21, 1950, 0-0-1. P. D. Pilsbury per Beck. Santa Barbara Co.: Santa Barbara, March 25, 1966, 0-0-3 and 1 tail piece. Beck. San Bernardino Co.: Victorville, one-half mile west of bridge over Mojave River, in wet, coarse sand under algal compost, September 1, 1950, 0-0-1 (Hercynian morph). Beck.

Remarks.— These are the first records of *E. tetraedra* for the southern part of the state.

Reproduction, in *E. tetraedra*, is parthenogenetic and often is obligatorily so because of male sterility. Although male sterile morphs of many species had been studied and named by oligochaetologists, the sterility for long was not even suspected. Megadrile parthenogenesis was first proved experimentally in *E. tetraedra* by raising isolated hatchlings to maturity in the laboratory.

Idaho.— Butte Co.: Arco, to the south about 1 mile, heavy black clay loam at water's edge and a more loose and only slightly moist soil a few feet above the water's edge, May 31, 1952, 2-1-16. Beck, Mary Clark, Grace Grant. Canyon Co.: Middleton, four inches below surface of an area with sod where logs and other detritus had accumulated near Boise River, June 19, 1954, 0-0-1. Beck. Clark Co.: Birch Creek, *ca.* 15 miles south of Lemhi County border, wet to moist sand and under stones at stream's edge, at 6500 feet, June 3, 1952, 0-0-1. Beck. Custer Co.: Challis, several miles to the south, at *ca.* 6500 feet, moist to wet soil and under rocks at side of a small mountain streamlet, May 31, 1952, 20-12-52. Mary Clark, Grace Grant, Beck. Kootenai Co.: Worley, under logs and other debris at bank of a stream that ran into a marsh land, June 24, 1954, 1-4-13. Beck. Lemhi Co.: Salmon, 11 miles to the north, *ca.* 4100 feet, from fibrous root system of grassy turf of a relatively dry meadow near Salmon River, June 1, 1952, 0-0-1. Beck, Mary Clark, Grace Grant. Hill side seep spring area, on Route 93, 1 mile north of town, May 31, 1952, 0-0-2. Beck. Lincoln Co.: Shoshone Falls, beneath rocks at edge of pools, streams and springs, June 19, 1954, 0-0-24. Beck.

Remarks.— *E. tetraedra* is the seventh species to be recorded herein for the first time from Idaho.

Nevada.— Lyon Co.: Wabuska, July 5, 1966, 0-0-25. E. V. Komarek, Sr. Ormsby Co.: Carson River, south of Silver Spring, July 5, 1966, 0-0-20. E. V. Komarek, Sr. White Pine Co.: McGill, drain north of a swimming pool which is northwest of the town, August 5, 1950, 1-1-4. Beck. Kennicot Duck Creek Station, one mile to the

south, at stream edge, wet heavy clay soil with organic matter, August 5, 1950, 1-2-23. Beck.

Remarks.— *E. tetraedra* is the eighth species to be recorded herein for the first time from Nevada.

Utah.— Beaver Co.: Wahwah Springs, September 12, 1952, moist soil along stream bank, and under rocks near the marshy area, 5-0-12, under rocks near edge of desert spring and its run-off, 0-0-3. Beck. Box Elder Co.: Lucin, seven miles to the north, at a desert spring where water was salty and vegetation was of the alkaline desert type. June 19, 1-0-0. Beck. Washington Co.: Zion National Park, at 6000 feet, under plant cover of sage and juniper, near Uintah Mountains, June 12, 1955, 0-0-1. Beck. Piute Co.: Marysvale, 2 miles south of Big Rock Candy Mountain on Route 89, with fibrous root system of grass and sedge quite close to water level in Sevier River. June 26, 1952, 0-1-15. Beck. Rich Co.: Randolph, abundant along bank of Otter Creek, at 6600 feet. August 21, 1952, 0-0-9. Beck. Sanpete Co.: Mt. Pleasant, Pleasant Creek Picnic Grounds, at contact line of conifers and aspens, beneath bark and under fallen trees. August 5, 1951, 0-0-9. Beck. Utah Co.: Mt. Nebo, at 8600 feet, under stones, logs, boards near a bog on north side of mountain on the Loop Road. September 21, 1952, 0-0-15. Lehi Sugar Factory Area, in wood of a rotted board near pond, April 25, 1952, 0-0-1. Beck. (Elsewhere in the area no worms were found.) Washington Co.: St. George, almost pure clay at edge of an irrigation ditch from Virgin River, September 2, 1950, 1-0-6. Beck.

Remarks.— *E. tetraedra* is the eighth species to be recorded herein for the first time from Utah.

Montana.— Mineral Co.: Saltese, 3 miles east of Lookout Pass on Route 10, at about 4000 feet, mucky black forest soil near a small stream or in a coarse sand and gravel mixture by the stream side. June 25, 1954, 0-0-1. Beck. Ravali Co.: Hamilton, four miles west and near Blodget Creek at 3600 feet, upper 3-4 inches of black soil mixed with sand under *Pinus ponderosa*, June 1, 1952, 1-0-0. Beck.

Remarks.— *E. tetraedra* is the sixth species to be recorded herein for the first time from Montana.

Wyoming.—Carbon Co.: Spring Creek, 2 miles south of Saratoga on Route 130. June 7, 1961, 0-0-2, (Hercynian morph). North Brush Creek, 1 mile west of Medicine Bow Natural Forest Line on Route 130, June 7, 1961, 0-0-1. G. F. Edmunds & W. L. Peters. Fremont Co.: Lander, sandy soil near Papaogie Creek at south side of city park. August 30, 1952, 1-1-11 (of which 1-1-8 are of Hercynian morphs). Beck. Yellowstone National Park. September 1, 1952, 0-0-5. Beck.

Remarks.— *E. tetraedra* is the sixth species to be recorded herein for the first time from Wyoming.

Colorado.— Chaffee Co.: Buena Vista, Rancho Sawatch. August 14, 1953, 0-0-6. Ottys Sanders. Grand Co.: Hot Sulphur Springs, under stones along edge of Colorado River south and west of the

town about seven miles, August 28, 1952, 0-4-38 (0-4-32 of the Hercynian morph). Beck. Larimer Co.: Fort Collins, August 29, 1952, eight inches of dark, compact sandy loam above water level in seepage area at base of South Reservoir, 2-0-0. Beck. Routt Co.: Along the Yanipa River, *ca.* 2 miles north of Steamboat Springs, under stones, boards, logs, and in loose soil near willow clumps in a small meadow, August 27, 1952, 0-0-5 (1 of Hercynian morph). Beck. Summit Co.: Frisco, one mile to the northeast, August 13, 1953, 0-0-2. Ottys Sanders.

Remarks.— These are the first records of *E. tetraedra* for named Colorado localities. The species was recorded (Smith, 1917) for the state but without specification as to county or otherwise.

South Dakota.— Lawrence Co.: Spearfish Creek, 0.8 miles south of hydro plant no. 2, June 9, 1961, 0-0-1. G. F. Edmunds & W. L. Peters.

Remarks.— Although earthworms are known to have been present in South Dakota for some years (*cf.* Taylor, 1924) the record above is the first in print for an identified species.

Dakota, according to Seton (1929), had no earthworms. The northern state probably had little European settlement till after 1862. First European settlers, other than traders and trappers, arrived in the southern state in 1850.

Taylor stated that earthworms "do not thrive in acid soils such as are found in the great plains section of North America . . . . They are generally plentiful in silt soils along streams . . . . The most productive soil I have ever planted was full of them, always was, and is today. The only fertilizer it ever gets is silt from over-flow of the river, and the same land has been farmed for over seventy years."

The soil of 1,310 square miles in 6 counties of eastern South Dakota is unusually interesting. The average depth is 36 inches in an area with an east-west width of 16-32 miles and a north-south length of 75 miles. Because that soil consists almost entirely of worm casts and filled worm channels it was named (Buntley & Papendick, 1960) Vermisol. Worm activity had almost completely destroyed horizontal zonation.

Like Darwin (in the title of his last book, "The formation of vegetable mould through the action of worms") Buntley & Papendick presumably expected us to deduce that worms = earthworms as they did not once use that word. A request for information brought the following reply (Buntley, *in lit.* Oct. 18, 1960), "I did collect some worms from each of the two worm-worked soils. These were identified as *Lumbricus terrestris* by our entomology department."

European settlement in South Dakota began after 1850. Less than a hundred years (*cf.* Gates, 1966) was probably available for the destruction, by earthworms, of soil zonation to an average depth of three feet. At first that does seem like too much to expect even of

the kind of animals so highly praised by organic gardeners. *L. terrestris*, according to Olson (1928, p. 59), "has become widely distributed over Ohio in the last ten years." Such spreading capacity presumably could enable the required Dakota distribution through a much smaller area in less than a hundred years. However, the identity of the species involved is by no means certain. Far too often, even today, *Lumbricus terrestris* is THE earthworm. Conversely any earthworm easily becomes *L. terrestris*. Within the last twelve years, *Eisenia foetida* and *Allolobophora tuberculata* have appeared as *Lumbricus terrestris* in scientific journals, probably also *A. trapezoides* and *longa* and one or more other megadrile species the identity of which cannot even be guessed.

Evidence supporting a rapid rate of zone-destruction by earthworms may be unpublished in field notes of various pedologists. Between the spring of 1958 and 1961, according to K. K. Langmaid (*in lit.*), Head of Canadian Soil Survey, soil horizons (at a Carlingford, New Brunswick, cut-over forest site) had been obliterated by earthworm action, to a depth of six inches. The species in the sample from that site were *Allolobophora tuberculata* (4 specimens), *Lumbricus terrestris* (1).

The Dakotas unfortunately were not visited by Beck. From the northern state two species have been recorded, *Eisenia foetida* from earthworm farms, *Microscolex phosphoreus* from a greenhouse. Nothing at all is known about megadrile populations of natural habitats.

Lumbricus Linnaeus, 1758

Lumbricus castaneus (Savigny, 1826)

IDAHO.— Lemhi Co.: Bitterroot River, near continental divide on Route 93, June 1, 1952, 0-0-1. Beck.

REMARKS.— *L. castaneus* is the eighth species to be recorded herein for the first time from Idaho. The species appears to be much less important in the western faunas of the United States (*cf.* below). In central Maine, on the contrary, *castaneus* is fairly common but *rubellus* is rarely found.

Reproduction, in *L. castaneus*, is obligatory biparental.

Lumbricus rubellus Hoffmeister, 1843

IDAHO.— Fremont Co.: "Osborne Springs," *ca.* 25 miles north of Ashton on Route 191, heavy black loam, 6-8 inches below surface, in process of "balling," surface quite dry, September 1, 1952, 3-3-4. Beck. Lincoln Co.: Shoshone Falls, damp porous black soil, under rocks in grassy area and 2-8 inches below surface of soil, June 18, 1954, 0-0-1.

REMARKS.— *L. rubellus* is the ninth species to be recorded herein for the first time from Idaho.

Utah.— Weber Co.: Ogden, depressions in the flood plain where plant growth is rank, September 3, 1952, 0-0-2. Beck.

Remarks.— *L. rubellus* is the ninth species to be recorded herein for the first time from Utah.

Colorado.— Routt Co.: Along the Yanipa River, *ca.* 2 miles north of Steamboat Springs, under stones, boards, logs, and in loose soil near willow clumps in a small meadow, August 27, 1952, 1-1-10. Beck.

Remarks.— This is the first record of *L. rubellus* for Colorado.

Reproduction, in *L. rubellus*, is obligatorily amphimictic.

Lumbricus terrestris L., 1758

Idaho.— Bannock Co.: Pocatello, June 3, 1952, 0-0-1. Beck. Latah Co.: Moscow, Palouse soil in lawns of University of Idaho, March 15, 1950, 0-0-2. C. W. Lame.

Remarks.— *L. terrestris* is the tenth species to be recorded herein for the first time (by its scientific name after a definite identification) from Idaho.

Writing about "night crawlers," Painter (1942) said, "Many people in Twin Falls, Idaho get night crawlers for bait from lawns by electricity. The worms supposedly had been imported originally from the East." Night crawler is a common name for *Lumbricus terrestris*. Nevertheless, use of that common term is no guarantee that an identification as *terrestris* would be correct. The fact that electricity was used to secure the worms itself is a contra-indication. Night crawlers, when conditions are favorable, feed and copulate on the surface at night where they are easily "jacked," without electricity, by those familiar with their habits. Millions are easily collected that way every year in this country. If conditions are unfavorable for surface activity, the crawlers are likely to be too deep down to be brought out by a superficial electric current. American allolobophoras, on the contrary, are not known to feed on the surface at night. They are geophagous and more likely to be active at soil levels where they could be stimulated by electricity.

Utah.— Morgan Co.: Weber Canyon, at 5600 feet, about 6 miles east of Coalville, July 11, 1952, 0-0-1. Beck. Summit Co.: Wanship, at 5900 feet, two feet above stream bed, six inches under sod kept moist by ephemeral seepage, July 13, 1962, 4-0-1. Beck. Utah Co.: Provo, April 12 or May 13, 1951, 0-0-1. Beck. Washington Co.: Pine Valley, July 16, 1953, 0-0-2. Beck.

Remarks.— *L. terrestris* is the tenth species to be recorded herein for the first time from Utah. The paucity of records above, surprisingly, may be due to the commonness and usefulness of the species. Beck remembers watching in the fall of 1925 "jacking" of night crawlers in the long practiced manner. By that time the species must have been common around Provo at least. Today, Beck reports, along the highways of the state one sees numerous signs signifying night crawlers for sale. He also mentioned that " jacking"

still is a nightly summer activity unless a fastidious lawn owner has treated his grassland with Pax or chlordane.

Colorado.— Grand Co.: Hot Sulphur Springs, moist, loose dark soil with fibrous grass roots along back of Colorado River about 7 miles southwest of the town, August 28, 1952, 9-0-1. Beck. Routt Co.: Along the Yanipa River, *ca.* 2 miles north of Steamboat Springs, under stones, boards, logs and in loose soil near willow clumps in a small meadow. August 27, 1952, 1-0-3. Beck.

Remarks.— *L. terrestris* was recorded from Colorado once before (Smith, 1917) but without specification as to places or sites from which the worms were obtained.

Iowa.— Jefferson Co.: Fairfield, Parsons College campus, May 22, 1951: Mud flats of a small stream on north side, 1-0-1. Wooded slope southwest of flats, 2-0-0. F. W. Von Ohlen.

Remarks.— Reproduction, in *L. terrestris*, is obligatorily biparental.

Octolasion Oerley, 1885

Octolasion cyaneum (Savigny, 1826)

Colorado.— Larimer Co.: Stonewall Creek, 30 miles south of Wyoming border on Route 287, loose sandy soil with much humus, in sodded area where willow growth was rank, August, 1952, 0-0-1. Beck.

Remarks.— This is the second trans-Mississippi record of the species which is but rarely found anywhere in the American hemisphere.

Reproduction, in *O. cyaneum*, is obligatorily parthenogenetic. Polyploidy has been reported.

Octolasion tyrtaeum (Savigny, 1826)

Idaho.— Butte Co.: Arco, to the south about 1 mile, heavy black clay loam at water's edge and a more loose and only slightly moist soil a few feet above the water's edge, May 31, 1952, 0-0-1. Beck, Mary Clark, Grace Grant.

Remarks.— *O. tyrtaeum* is the eleventh species to be recorded herein for the first time from Idaho.

Reproduction, in *O. tyrtaeum*, is obligatorily amictic. Male sterility is common. Polyploidy has been reported.

Utah.—San Juan Co.: Elkhorn Ranger Station, Thousand Lake Mt., at 9700 feet, damp, loose black soil, under rocks and dead timber and in a forest of quaking aspen, *P. tremuloides*, August 9, 1952, 0-0-1. Beck.

Remarks.— *O. tyrtaeum* is the eleventh species to be recorded herein for the first time from Utah.

Colorado.— Chaffee Co.: Buena Vista, Rancho Sawatch, August 14, 1953, 0-0-1. Ottys Sanders. Larimer Co.: Stonewall Creek, 3 miles south of Wyoming border on Route 287, loose sandy soil with much

humus, in sodded area where willow growth was rank, August 29, 1952, 0-1-16. Beck

Remarks.— Early settlers, according to Cockerell (1924), maintained they found no earthworms in mountainous districts or in adjacent upland plains of the state.

D. tyrtaeum was reported once from Colorado, as *O. lacteum*. The same author (Smith, 1917) recorded for the state the following valid species: *A. chlorotica*, *D. octaedra* and *rubida*, *E. tetraedra*, *L. terrestris*. Except for *D. octaedra* which had been taken only at Boulder, no data as to counties, sites and number of specimens was provided.

Nebraska.— Laurence Co.: Hickman, June 11, 1960, 0-0-3. W. R. Murchie.

Remarks.— *O. tyrtaeum* previously had not been recorded from Nebraska, even as its synonym, *O. lacteum*.

Species previously reported from th state are seven: *A. caliginosa* (now known to have been a complex of four or more species), *B. parvus*, *E. foetida*, *Pheretima diffringens*, and three diplocardias of uncertain status. The single record of *P. diffringens*, soil near University greenhouses at Lincoln, probably is indicative of the way this oriental species reached the state.

"Settlement began in a small way in 1854," according to P. W. Gates (*in lit.*) but increased considerably after 1862 when a Federal Homestead Act provided free land for veterans.

Iowa.— Sioux Co.: Ireton, under maple trees in yard near farmhouse. 5 miles from the village, April 21, 23-3-25. Mary M. Jinks.

Remarks.— *O. tyrtaeum* was recorded in 1948 from Iowa as *O. lacteum*. Other megadrile records for the state are: *Sparganophilus eiseni* (a North American endemic that is widely distributed), *Allolobophora trapezoides*, *A. caliginosa* (probably *A. turgida*), *Eisenia foetida* and *rosea*, *Lumbricus terrestris*, and *Octolasion cyaneum*.

There was, according to historian P. W. Gates (*in lit.*), "Not much settlement before 1836-1938."

Megascolecidae

Pheretima Kinberg, 1866

Pheretima hawayana (Rosa, 1891)

California.— Los Angeles Co.: Los Angeles, lawn, June 1955, a number of clitellate individuals. A. W. Bell.

Remarks.— Reproduction, in *P. hawayana*, probably is obligatorily amphimictic. The original home of the species is in eastern Asia.

Pheretima hupeiensis (Michaelsen, 1895)

Utah.— Utah County: Provo, Brigham Young University campus, January 31, 1966. 0-2-14. Beck.

REMARKS.— *P. hupeiensis* is the twelfth species to be recorded herein for the first time from Utah. The species had been recorded previously from Louisiana but nowhere else west of the Mississippi River.

The following information about this species was provided by Beck (*in lit.*, June 20, 1966): Each spring and fall and at periods of warmth, which occurred in January of this year, these worms crawled from the lawns by the thousands to the sidewalks, creating quite a squishy situation for the students walking back and forth from the buildings.

Reproduction, in *P. hupeiensis*, is parthenogenetic, probably often because of male sterility.

Directly or indirectly, the species may have come from China.

OCNERODILIDAE

Ocnerodrilus Eisen, 1878

Ocnerodrilus occidentalis Eisen, 1878

This species has been reported occasionally from the desert region. Types were found in California and of course the species was thought to be native to that state. Somewhat later, specimens from China and Hawaii, were intercepted at San Francisco. They were obtained from soil with potted plants. Presumably the species had been transported around the world for several centuries. Even today, the original home of *O. occidentalis* is unknown. Central Africa and tropical America have been postulated.

Absence of specimens in recent collections may be of little or no significance. However, colonization could have been temporary. Similar failures to achieve permanent domicle are believed to have occurred in the faunas of oceanic islands such as Hawaii and St. Helena.

Reproduction is parthenogenetic.

APPENDIX

No collections were available for several states that need consideration herein. Some of Professor Beck's collections were lost in transit which is much regretted because of our ignorance of earthworm faunas.

KANSAS.— Earthworms originally were lacking in Kansas according to Wilcox (1884). There was little European settlement till 1851. By 1917, Smith was able to report three species of *Bimastos*, *parvus*, another now known as *tumidus*, and *welchi*, known only from the original description based on sections of the single type. The latter, according to Smith, was immature. None of the three are native to Kansas. A specimen of a double-tailed worm from Kansas (Harnly, 1932) was said to be of *Lumbricus terrestris* but that too often, even today, means nothing more than "earthworm."

Oklahoma.— Earthworms were lacking in the prairies of Indian Territory according to Wilcox (1884). Since 1954 the following were reported from Oklahoma, *Allolobophora caliginosa* (most probably in large part if not wholly, *A. trapezoides*), *Eisenia foetida* and *rosea*, each of which is present in desert states, *Bimastos tumidus* (the original home of which is unknown), and four diplocardias of uncertain status, three of which were not reported from Missouri and Arkansas.

Minnesota.— *Lumbricus terrestris* was the first earthworm recorded (Smith, 1917) for Minnesota but as usual without data to localities and number of specimens. Mickel (1925), who studied earthworm parasites, provided a little information. *A. caliginosa* was the most abundant earthworm at St. Paul. *L. terrestris* was the second most abundant. *E. foetida* was found only in compost and then not commonly. Mickel's *caliginosa* is less likely to have been *trapezoides* than *tuberculata* or *turgida* or both. Except for those parasites, presence of *L. terrestris* would be the extent of our knowledge of the earthworm fauna of Minnesota in 1967. Each Minnesota species is present in the desert states.

Missouri.— The megadrile fauna of this state comprises the following: *Allolobophora caliginosa* (perhaps in part not *A. trapezoides*), *chlorotica* and *trapezoides*, *Bimastos heimburgeri* (of uncertain status), *tumidus* and *zeteki*, *Dendrobaena rubida*, *Eisenia foetida* and *rosea*, *Eiseniella tetraedra*, *Lumbricus rubellus* and *terrestris*, *Octolasion tyrtaeum* of the *Lumbricidae*, *Pheretime agrestis* of the Megascolecidae, *Sparganophilus eiseni* and 5 diplocardias of uncertain status four of which also are recorded from Arkansas.

Nine of those species are present in desert states, 10 obviously are exotic. Original homes of the diplocardias, species of *Bimastos* and *S. eiseni* are unknown but now seem unlikely to have been in Missouri.

Arkansas.—Megadriles recorded for this state are: *A. caliginosa* (probably in large part, if not all. *A. trapezoides*), *Bimastos parvus* (in which *beddardi* and *longicinctus* may have to be included), *tumidus* and *zeteki*, *Dendrobaena octaedra* and *rubida*, *Eisenia foetida*, *hortensis* (recorded as *B. venetus*), and *rosea*, *Eiseniella tetraedra*, *Lumbricus rubellus* and *terrestris*, *Octolasion tytraeum*, *Pheretima californica*, *diffringens* and *hupeiensis*, four diplocardias of uncertain status.

Eleven of those species are present in desert states. Thirteen obviously are exotic, and three pheretimas being of Asiatic origin, the others of European origin. Species of *Bimastos*, as well as one diplocardia, are unlikely to have originated in Arkansas.

Discussion

A sample of little more than 2500 worms may seem too small to warrant discussing the megadrile fauna of an area containing more than a million square miles. As a result, mainly of the activity of

Prof. Beck, we do know much more about the earthworms of the desert area than before. Each of the following pairs indicates number of species previously and now known from the mentioned states. Arizona 3-8, California (southern part only) 1-7, Colorado 6-12, Idaho (one small section excluded) 0-11 (with no exclusion, 1-12), Iowa 8-8, Montana 0-6, Nebraska 7-8, Nevada 0-13, New Mexico 0-2, North Dakota 2-2, South Dakota 0-1, Utah 0-12, Wyoming 0-6. Numbers of species known from adjacent states are: Kansas 3, Oklahoma 8, Minnesota 3, Missouri 19, Arkansas 20.

Number of species now known from desert states is 21, larger than the number recorded for anyone of the adjacent states with much more rainfall (*cf.* Table 1).

Every one of those 21 species obviously is exotic in the area, most of the lumbricids having come from Europe, one probably from somewhere east of the Mississippi, and megascolecids from Asia. The original home of the ocnerodrilid is unknown, but is unlikely to have been in North America. Prof. Beck has found absence of endemics in such a large area hard to believe, as will many others.

Exotics could have gotten to the desert region in two ways. The first of course is by migration. This is the view of some Europeans (*cf* Omodeo, 1963). European species moved across the north Atlantic to Greenland, Iceland and eventually to the American mainland. There, they alone survived the great glaciations that pauperized, perhaps permanently, the megadrile fauna of North America. Geologists seem to be unaware of proof that an Atlantic bridge existed at the proper time (*cf.* Wright & Frey, 1965). Survival of soft-bodied, moisture-loving animals through countless millenia on bare nunataks seems unlikely.

The other way by which the exotics could have gotten to desert states is by introduction. That is likely to have resulted only from human activity. Supporting evidence for introduction is of two sorts. Data of the first sort got into print as a direct result of the publication in 1881 of Darwin's last book, "The formation of vegetable mould through the activity of worms." Parenthetically it is well to note that the worms are earthworms. The conditions Darwin thought resulted only from megadrile activity existed in the great plains of Canada where there were then no earthworms. Seton (1929) concluded his study of the subject in the following words:

"Since 1882, I have made personal investigations in parts of Saskatchewan, Alberta, Southeastern British Columbia, Dakota, Wyoming, Montana, Idaho, Colorado, New Mexico, Arizona, and the mountains and dry parts of California: and made numberless inquiries covering the western part of the Mississippi drainage, as well as all the adjoining mountains without hearing of any earthworms excepting in localities where they were introduced. (They have recently appeared in many highly cultivated parts of Manitoba.)"

"Further, I am satisfied that, excluding the narrow humid belt along the Pacific Coast, earthworms are not native to any part of

America south of the Great Slave Lake, or west of the immediate Mississippi Valley. Probably the true earthworm is not native to any part of North America." (Presumably by "true earthworm" was meant *L. terrestris*.)

As further support for Seton's conclusions, his "narrow humid belt along the Pacific coast" is where Eisen found endemics unrelated to those of any other section of the United States. A northern portion of that same belt is where Macnab and McKey-Fender were finding endemics until their research was abandoned. Also according to Repenning (1966), "The Pacific Coast Province has remained a more or less isolated faunal unit since the early part of the mammalian history."

Presence of lumbricid exotics in other parts of the world, where endemics could be expected but were lacking, usually was blamed on native inability to survive competition. Those ideas were summarized by Stephenson (1930, p. 905) as follows. "The Lumbricidae are a recently evolved and dominant group which possesses great powers of adaptation to new surroundings. Numerous species have been carried by man and have established themselves all over the world. Their introduction into a new territory frequently causes the disappearance of the endemic earthworm fauna." The Lumbricidae no longer can be regarded as recently evolved, the range from the Mississippi River across Europe and Asia to Japan is the largest of any megadrile family and must be of considerable age. Furthermore, when pending revisions are completed American endemics will not be in the same genera as now are the European species. Nor is the family as a whole characterized by great powers of adaptation and dominance. A few species, perhaps less than a dozen, in the struggle for existence during Quaternary glaciation, may have acquired some unusual colonizing ability but at the same time lost any ability they may have previously had to maintain themselves in tropical climates except at high elevations. Many years ago G. E. Hutchinson collected 268 earthworms (Gates, in MS) in the vicinity of Naples, Italy, where considerable endemicity could be expected, but 240 belonged to the very species that colonized the Great American Desert. Seemingly, European endemics in their own home, lack dominance and marked ability to survive whatever may have been involved.

Anthropochorous forms very clearly have replaced endemics in many niches of various regions in Australia, New Zealand, South Africa and southern South America. By "replaced" nothing more need be understood than "taken the place of." In some of such niches, hemerophobic endemics may have disappeared as a result of human disturbance of their environment before arrival of the supposed competitors. Innumerable cases of transport and of first appearance of worms in a new area around farm houses and fields prove that exotics are hemerophilic and at least do tolerate considerable human interference with their environment. In New Zealand, Lee (1961) thinks replacement rather than competitive extermina-

tion was involved. Miller *et al.* (1955) say that exotics usually appear some years after disappearance of the endemic fauna.

A Washington State endemic, according to Altman (1936), was common in cultivated fields. As he had only ten specimens of the species, the cited observation may have been given him by some one unfamiliar with common similarities of many species. McKey-Fender (*in lit.* March 4, 1948) as a result of her experiences believed that "The natives quickly disappear under cultivation, being restricted almost entirely to the edges of fields or to uncultivated areas . . . . Old timers remark about their disappearance. In recent years, Ray Albright of Dayton, Oregon has noted them most often at the borders of his fields."

In South Africa, according to Pickford (1937), "The apparent displacement of endemic by peregine species in cultivated grounds is probably due to the fact that many of the latter can tolerate conditions which are inimical to the former, for example the continued breaking up and drying out of the soil." Pickford also mentioned instances of South African endemics coexisting, in uncultivated sites, with the exotic lumbricids.

In southwestern Australia, Michaelsen (1907) found that *A. caliginosa* had acquired a wide distribution and had become numerous near towns within seventy years of the first settlement by Europeans. Accordingly, the same lumbricids could have had time enough (*cf.* previous pages), since first European settlements in desert states, to acquire their present distribution. These instances are cited in part because some have thought (*cf.* Omodeo 1963) that far too little time since 1500 A.D. had been available for European species to acquire their present American distributions.

Earthworms are soft bodied animals without exoskeletal protection against dehydration. Water constitutes around 80 percent of body weight in *P. hupeiensis*, *A. caliginosa* (Grant, 1955), *A. chlorotica* and *L. terrestris* (Roots, 1956). Mechanisms for resisting dessication would seem to be of special survival value in the desert. A weight loss of 54 percent by cocoons of *Bimastos zeteki* did not prevent normal development (Murchie, 1960) when water was added. Similar ability often is imputed to other megadriles, especially in popular writings, but experimental proof is lacking. Earthworms of various species can survive a loss of 50-70 percent of their body water. Among those studied was *A. caliginosa* which Grant (1955) found to have the most efficient mechanism for resisting dessication. The American section of the *caliginosa* complex comprised three distinct species each of which could have differed from the others in such a mechanism. Which species was used in the experiments unfortunately is unknown. *A. trapezoides* is the species most frequently obtained in the desert states but is unlikely to have been consistently available in New England.

How much moisture is needed for normal earthworm activity and reproduction? Answers were first sought from precipitation data.

TABLE: Precipitation

State	Rainfall in inches	Remarks
Arizona	3.1 to 32.4	
Arkansas	48.64 (normal)	
California (southern)	10-20 or 0-10	
Colorado	17	7-60
Idaho	8-25	
Iowa	31.44	
Kansas	27	
Missouri	40.15	
Montana	10.15	Or 20 in northwest and on mountains
Nebraska	12.65-27.58	But dry years in irregular cycles
Nevada	3-12	
New Mexico	14.3	
North Dakota	14-22	
Oklahoma	16.51-46.53	
South Dakota	14-24	
Utah	5-40	Latter only in Wasatch Mts.
Wyoming	14.79	6 in parts, to 35 on mountains

Figures are from state articles, Encyclopedia Britannica, (1965). Some authors gave only a single annual state average. Others gave annual averages for smaller regions.

"The average annual rainfall is one of the most important factors delimiting distribution of earthworms," according to Pickford (1937) whose studies were made in South Africa. There she found that endemic acanthodrilines were almost entirely restricted, in the south, by the 20 inch isohyet. In the north, localities of her native worms were bounded by the 30 inch isohyet. Pickford was most interested in the endemics and provided little information as to relationship between rainfall and distribution of the exotic lumbricids. Mention was made of the fact that exotics had been found in areas with less than 20 inches of annual rainfall. Seven lumbricid species (Gates, in MS) were represented in her collections. Each of those species is present in our desert states.

In Manchuria, Kobayashi (1940) found that an annual rainfall of less than 400 mm (*ca* 16 inches) was unfavorable to earthworms. He likewise was mainly interested in native taxa. "In the region where the amount of annual rainfall is less than 400 mm, no endemic species can exist." (p. 308). Some at least, if not all, of the supposed endemics, when revised, will fall, into synonymies of more or less widely spread anthropochores. Probably no single megadrile will prove to be autochthonous (evolved in, and not found elsewhere) in either Manchuria and Mongolia.

Beck collected earthworms in various areas where average annual rainfall is much less than 16 inches and indeed, may amount only to 3-10 inches annually. Surprisingly, the species represented in the desert region by the third largest number of specimens is *E. tetraedra.* This form rarely is found away from water and usually is charac-

terized as amphibious, limnic, hygrophile or as a dweller in purely aquatic habitats. Obviously something more than annual rainfall must be involved.

Check of habitat data reveals that more than half of the desert earthworms (all species) were obtained from banks of creeks, rivers, springs, from seepage areas, marshes, and similar sites. Many other specimens for which site data are lacking, possibly, if not also probably, were from similar habitats. The common factor of each of those habitats is presence of more moisture than would be provided by the annual rainfall. Important and suggestive data were provided for one locality by Barrett. He found the worms in a strip of land ten feet wide, on each side of the creek. In soil 10-50 feet from the creek bank worms were absent.

A monthly rainfall of 11-22 inches in certain sections of Burma completely fails to keep many species from going into a state of hibernestivation (Gates, 1961). Annual averages of rainfall may then be of little or no significance in some desert areas. If so, amount of moisture in soil will determine earthworm survival. Involved will be maintenance of adequate soil moisture for a period long enough to permit completion of a life cycle. Little information is available about life cycles in different climates but in Europe information is being acquired about moisture factors and earthworm survival.

In Hungary, Zicsi (1958) found that individuals of *A. caliginosa* are active only when water content of the soil is at or above 30% of capillary capacity. Four or more species have been involved in the European section of the *caliginosa* complex. Similar figures for validly defined species present in America were, *rosea* 35 percent, *chlorotica* 40 percent, *tyrtaeum* (as *lacteum*) 30 percent.

Parthenogenesis usually is thought to favor colonization of new areas (*cf.* Muldal, 1952) as only one specimen is needed. However, a single specimen of an obligatorily amphimictic individual also can start a new colony—after its battery of spermathecae has been charged with sperm (millions?) as a result of copulating with another individual. Of the 21 species living in the desert states, 12 reproduce parthenogenetically. The other 9 are obligatorily amphimictic. Of the 2500+ individuals, over 1800 were of parthenogenetic species. Less than a third were of amphimictic species. Parthenogenesis has not enabled lumbricids to colonize tropical lowlands. Other factors, such as efficiency of drouth resisting mechanisms, may be of equal or even greater importance especially in desert regions.

If earthworms were absent in plains and desert states when settled by Europeans, the species now known to be domiciled there must have been introduced and, for most of the region, within the last 100-120 years. But how much reliance is to be placed on Seton's observations? Considerable, according to Wilcox (1884) who confirmed and even added to them. Introduction could have been accidental or deliberate. Very many if not most may have been accidental (*cf.* p. above), in soil or other materials around roots of

imported plants. Some introductions were deliberately made in order to have a supply of bait for angling. Reports of deliberate introduction (*cf.* p. 144) provide additional support for previous absence of angleworms. Probably only a very few of the deliberate introductions got reported in print elsewhere.

Some reluctance to accept Seton's conclusions completely might be in order. Travellers have reported absence of earthworms in certain parts of the tropics or adjacent areas. Observations were made in the dry season when the soil was sun baked almost to brick hardness. Worms were estivating at the proper depths in the soil from which they return when the surface became satisfactorily moist. In some Asiatic deserts earthworms remain inactive during drouths of several years. It is of course possible that Seton and Wilcox did make some of their observations in wrong seasons or that they did not investigate inaccessible areas where conditions might have been more favorable. However, Beck's collection provided confirmation. Seton's wording "west of the immediate Mississippi Valley" might also be acceptable if we knew how far west is meant by "immediate." If an eastern part of Texas, some portions of Oklahoma and Arkansas are "imbediate" that is where endemics are now expected.

Before the recent ice ages, lumbricid earthworms probably were widely spread throughout much of the northern hemisphere. Quaternary ice sheets thousands of feet thick exterminated all earthworms for varying distances south of the present pole, in Europe and Asia as well as in America. Evidence proving that extant endemics migrated north in America since recession of the ice is lacking, though such migration frequently must have been assumed. Earthworm extermination was not confined to glaciated portions of Canada and United States. For as yet unknown distances below the southern ice face, the climate was too frigid for earthworms. The very few American lumbricids that did survive, except for *B. parvus*, appear to have little colonizing ability. A few European species, including those now domiciled in the desert states, not only survived, perhaps in nearest proximity to the ice, but even evolved a physiology better adapted to colonizing Iceland, Greenland, Siberia, than tropical lowlands.

Providing an explanation for absence of earthworms in unglaciated portions of the Great Basin states, now seems likely to be more difficult. Until unquestioned endemics are found there, it is necessary to suppose that these animals never lived there or were exterminated, before arrival of Europeans, by unfavorable climatic factors.

References

Buntley, G. J., and R. I. Papendick. 1960. Worn worked soils of eastern South Dakota, their morphology and classification. Proc. Soil Sci. Soc. America. 24:128-132.

Cockerell, T. D. A. 1924. Earthworms and the cluster fly. Nature, 113:193.

Darwin, C. 1881. The formation of vegetable mould through the action of worms, with observations on their habits. London. vii + 328 pp.

Gates, G. E. 1942. Check list and bibliography of North American earthworms. American Midland Nat. 27:88-108.

———. 1956. On another lumbricid earthworm with "*relictus*" characteristics and the disposition of Southern's species. Ann. Mag. Nat. Hist. (12)9:369-373.

———. 1961. Ecology of some earthworms with special reference to seasonal activity. American Midland Nat. 66:61-86.

———. 1966. Requiem—for megadrile Utopias. A contribution toward the understanding of the earthworm fauna of North America. Proc. Biol. Soc. Washington, 79:239-254.

Grant, W. C. 1955. Studies on moisture relationships in earthworms. Ecology, 36:400-407.

Hallock. 1877. The sportsman's gazeteer and general guide. Forest & Stream Publishing Co., New York.

Harnly, H. J. 1932. Double-tailed earthworm. Trans. Kansas Acad. Sci. 35:99.

Hollon, W. E. 1966. The Great American Desert, p. 284. New York City.

Kobayashi, S. 1940. Terrestrial Oligochaeta from Manchokuo. Sci. Rept. Tohoku Univ. (4, Biol.), 15:261-315.

Lee, K. E. 1959. The earthworm fauna of New Zealand. New Zealand Dept. Sci. Indust. Res. Bull. 130, 486 pp.

Michaelsen, W. 1900a. Abhandl. Naurwiss. Ver. Hamburg, 16.

———. 1990b. Oligochaeta. Das Tierreich, 10:575 pp. Berlin.

———. 1907. Oligochaeta. *In* Die Fauna Südwest-Australiens. Jena.

———. 1910. Zur Kenntnis der Lumbriciden und ihrer Verbreitung. Ann. Mus. Zool. St. Petersbury, 15 pp.

Mickel, C. E. 1925. Notes on *Zygocystis cometa* Stein, a gregarine parasite of earthworms. Jour. Parasitol. 11:135-139.

Miller, R. B. *et al.* 1955. The biological and chemical changes following shrub burning on a New Zealand hill soil. New Zealand Jour. Sci. Tech. (B)37: 290-313.

Muldal, S. 1952. The chromosomes of the earthforms. I. The evolution of of polyploidy. Heredity, 6:55-76.

Murchie, W. R. 1960. Biology of the oligochaete *Bimastos zeteki* Smith & Gittins (Lumbricidae) in northern Michigan. American Midland Nat. 64: 194-215.

Olson, H. W. 1928. The earthworms of Ohio. Ohio Biological Survey Bull. 17:47-90.

Omodeo, P. 1952. Cariologia dei Lumbricidae. Caryologia, 4:173-275.

———. 1963. Distribution of the terricolous oligochaetes on the two shores of the Atlantic. *In*: Love and Love, North Atlantic Biota and their History, pp. 127-151.

Painter, R. 1942. Letters. Nat. Hist. 50:225, 276.

Pickford, G. E. 1937. A monograph of the Acanthodriline earthworms of South Africa. Cambridge, England, 612 pp.

Repenning, C. A. 1966. Tertiary provincial and immigrant terrestrial vertebrates. Science, 151:863.

Roots, B. I. 1956. The water relations of earthworms. II. Resistance to dessication and immersion, and behavior when submerged and when allowed a choice of environment. Jour. Exp. Biol. 33:29-44.

Seton, E. T. 1904. The master plowman of the west. Century Magazine, 68: 300-307.

———. 1929. Lives of Game Animals. Vol. 4, part I. New York, Doubleday Doran & Co., Inc. (Citations are from pages 412-414.)

Smith, F. 1917. North American earthworms of the family Lumbricidae in the collections of the United States National Museum. Proc. U. S. Nat. Mus. 52:157-182.

Stephenson, J. 1930. The Oligochaeta. Clarendon Press, Oxford. xvi + 978 pp.

Taylor, S. C. 1924. Earthworms. Flower Grower, 11(10):405.

Wilcox, T. E. 1884. On the absence of earthworms from the prairies of the Canadian northwest. Nature, 29:406-407.

Wright, H. E. and D. G. Frey. 1965. The Quaternary of the United States. Princeton Univ. Press, x + 922 pp.

Zicsi, A. 1958. Einfluss der Trockenheit und Bodenbearbeitung auf das Leben der Regenwürmer in Ackerböden. Acta Agron. Acad. Sci. Hungaricae, 8:67-75.

A NEW NAME FOR A UTAH LEPIDIUM

James L. Reveal [1, 2]

For several years, Utah State University and the New York Botanical Garden have been working on the *Illustrated Flora of the Intermountain Region* which will have its first volume published in a few years. As a first step to preparing for the actual writing of the *Flora*, a checklist was written to summarize the known plants which occur in this area by Arthur H. Holmgren, Curator of the Intermountain Herbarium, and this author (1966). During the time of the writing of the checklist, several taxa were noted which seemed to be worthy of more study in the field and in the herbarium. One such taxon is *Lepidium montanum* Nutt. ex Torr. & Gray ssp. *demissum* C. L. Hitchc.

Questions regarding this subspecies were raised by the brief comments given concerning the possible relationships of it to *L. montanum* (sen. lat.) in general, and to *L. davisii* Rollins in particular. From the short description of ssp. *demissum*, and the more complete description of *L. davisii* (Rollins, 1948) which Hitchcock (1950) also reduced to the subspecific rank under *L. montanum*, it seemed that these two taxa did not fit properly into the *L. montanum* complex as previously defined by Hitchcock (1936). Thus, an isotype and other specimens of *L. davisii* were studied by the author at Idaho State University in 1963. The following year, attempts were made to find both ssp. *demissum* and ssp. *davisii* in their type localities, but no plants were found. In the spring of 1965, after a determined search for the ssp. *demissum* in its type locality in the lower end of Indian Creek Canyon, Duchesne Co., Utah, flowering specimens were finally found and studied.

During the author's Predoctoral Internship at the Smithsonian Institution, herbarium studies upon the entire *Lepidium montanum* complex were conducted at the United States National Herbarium, the New York Botanical Garden, and the Gray Herbarium of Harvard University. Additional studies were carried out on specimens at the various Utah herbaria at Logan, Salt Lake City, and Provo.

In the spring of 1967, the type locality of *Lepidium montanum* ssp. *demissum* was again visited and fruiting material obtained and studied. From these combined field and herbarium studies, evidence

1. The author would like to acknowledge the support given to him for field work from Utah State University and from National Science Foundation grants to Dr. Arthur Cronquist of the New York Botanical Garden for studies on the Intermountain Flora, a cooperative program between Utah State University and the New York Botanical Garden. Herbarium studies were mainly supported by the Smithsonian Research Foundation and conducted during the author's Predoctoral Internship program at the United States National Herbarium in Washington, D. C., from September 1966 to February 1967. This paper has been submitted to the Department of Botany, Brigham Young University, as partial fulfillment of two credits of Special Problems given during the Summer Session of 1967.

2. Department of Botany, Brigham Young University, Provo, Utah.

seemed to mount which indicated that *L. davisii* as well as the ssp. *demissum* were distinct species in their own right. As the epithet, *demissum* has been used at the species level for a South American *Lepidium*, it is necessary to provide a new name for the Utah plant which is now proposed as:

Lepidium barnebyanum Reveal, nom. nov.

L. montanum Nutt. ex Torr. & Gray ssp. *demissum* C. L. Hitchc., Madroño 10:157. 1950, non *L. demissum* C. L. Hitchc., Lilloa 11:121. 1945.

Pulvinate perennials, (4) 5-15 cm. high and up to 20 cm. across, the mats often forming raised humps; taproots deep, woody, once or twice divided and widely spreading, the caudices dichotomously branched 3-6 times, 2-5 cm. below the surface of the ground, invested with only a few old leaf-bases, each resulting caudex branch topped by a single, erect, green, leafy and herbaceous stem, the plants appearing glabrous and glaucous, yet with minute retrorse simple trichomes which are usually widely scattered nearly throughout the plants; leaves basal and cauline, the basal leaves linear to linear-oblanceolate, entire, ± v-shaped, 2.5-3.5 (4.5) cm. long, (1) 2-3.5 (4) mm. wide, the apices acute, the bases tapering gradually to slightly expanded clasping petiole-bases, these hyaline and membranaceous, 2.5-3.5 mm. wide; cauline leaves alternate along the stems and about equally spaced, 5-10 mm. apart, the leaves 8-25

Fig. 1. General growth pattern of a fruiting plant of *Lepidium barnebyanum* showing the pulvinate habit and the raised humps.

Fig. 2. Enlarged detail of the inflorescences of *Lepidium barnebyanum* showing the oblong-ovate fruits on the ascending pedicels and a few terminal flowers.

(30) mm. long, similar to the basal leaves but more reduced; racemes 1-2 (3) cm. in early anthesis, ± clustered, becoming 2.5-6 (8) cm. long in fruit although a few late flowers may be present, leafless, the simple trichomes more numerous than below; pedicels terete, slender, ascending, 3-5 mm. long; sepals greenish, 2 mm. long and 1-1.5 mm. wide, concave-convex, deciduous shortly after anthesis, flowers 3-4 mm. long and up to 7 mm. across, the petals white with the blades rotund, 2-2.5 mm. long and wide, narrowing to slender claws 0.8-1 mm. long, 0.3-0.5 mm. wide, the blades curving backwards from their bases; stamens 6, the singles slightly longer than the pairs, the filaments 2-2.5 mm. long, glabrous, the anthers yellowish, oblong, 0.8-1 mm. long; silicles oblong-ovate, (3) 4-5 mm. long, (2) 3-4 mm. wide, less than 2 mm. across, glabrous, not winged, the apices tapering to long, briefly truncated tips; styles 0.5-1.2 mm. long; cotyledons incumbent.

TYPE.— UTAH: Duchesne Co.: Indian Creek Canyon on white shale ridge-tops, ca. 4 mi. sw of Duchesne, 15 Jun 1947, *D. D. Ripley & R. C. Barneby 8699*. Holotype deposited at WTU! Isotypes: NY! US!

DISTRIBUTION.— Known only from a long ridge-top on the north edge of Indian Creek Canyon, ca. ½ mi. n of Utah Highway 33, 3.5-4 mi. sw of Duchesne, Duchesne Co., Utah, sec. 16-17, T. 4 S., R. 5 W., elevation 6400-6500 feet. Flowering in May and June, fruiting into July.

Specimens Examined.— Utah: Duchesne Co.: North ridge of Indian Creek Canyon, 3.5 mi. sw of Duchesne, *Holmgren, Reveal & LaFrance, 1959* (BRY, NY, UTC), *Reveal & Reveal 884* (BRY, CAS, DS, GH, MO, NY, OKL, RM, RSA, UC, US, UT, UTC, WTU).

Hitchcock (1950) considered *Lepidium barnebyanum* to be a subspecies of the highly variable and complex species, *L. montanum*, and most closely related to *L. montanum* var. *intergifolium* (M. E. Jones) C. L. Hitchc. However, I feel that the morphological differences between these two taxa are so great that the species rank which is now proposed seems much more logical. From *L. montanum* var. *intregifolium*, *L. barnebyanum* differs in its sparsely pubescent stems, leaves, and pedicels, the short linear to linear-oblanceolate entire leaves, the highly branched and compressed rooting system which results in the pulvinate mats, and in the oblong-ovate silicles. In several respects, and especially in the pulvinate habit, *L. barnebyanum* is similar to *L. davisii*, a species which

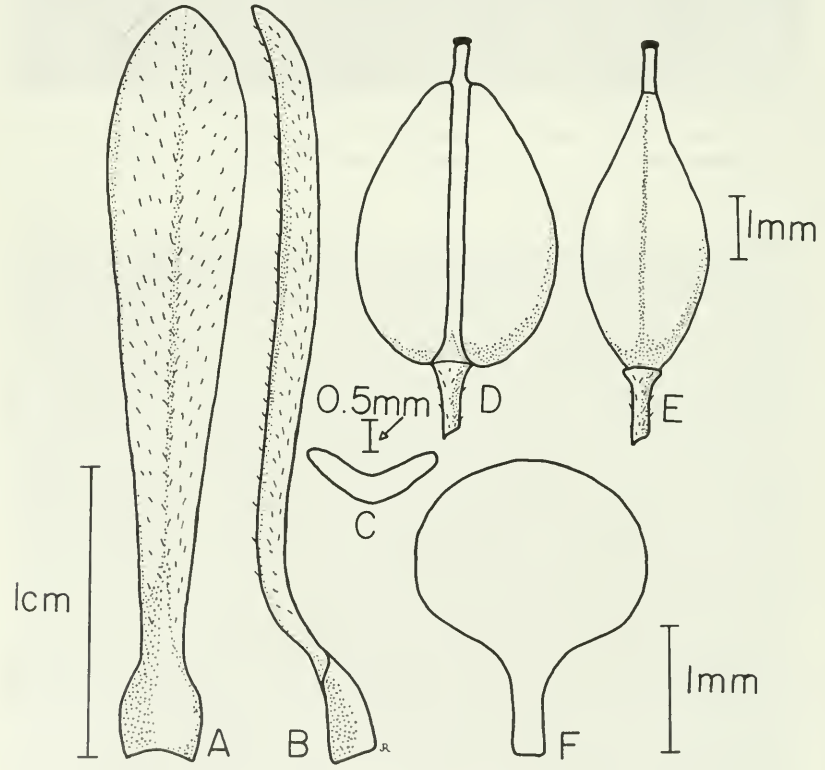


Fig. 3. Sketches showing the salient features of *Lepidium barnebyanum*. A-B—front and side views of a basal leaf, C—a cross section through a leaf showing a v-shape. D-E—front and side views of a mature silicle. F—an outline of a mature flower petal showing the rotund blade and the narrow claw-like base.

is apparently highly restricted to a dry bed of a small playa on a sagebrush mesa near the lava outcrops on the north rim of the Snake River Canyon, about 12-14 miles south of Mountain Home, Elmore Co., Idaho. However, *L. davisii* may be distinguished by its shorter leaves which are only 1-2 cm. long, denser pubescence, shorter stature (mostly under 8 cm. high), and its shorter silicles which are 3-3.5 mm. long. Unlike *L. barnebyanum*, the basal leaves of *L. davisii* are shorter than the cauline leaves.

In the field, the Utah *Lepidium* occurs with *Eriogonum batemanii* M. E. Jones and *Silene acaulis* L. var. *subacaulescens* (F. N. Will.) Fern. & St. John, on a broken white shale ridge in a Pinyon-Juniper woodland. It might be suggested that the pulvinate condition of *L. barnebyanum* is a result of the environment, but as most of the other plants on the ridge are found on the sides of the ridge and elsewhere in the Uinta Basin, the effects of the environment of these plants in the several areas where they have been observed does not seem to be an ecological response but rather due to a genetic basis which aids the plants to survive in these ecological niches. Thus, it is suggested that the pulvinate habit and the other morphological features of *L. barnebyanum* are not a result of its ecological niche, but rather a result of natural selection which has allowed for a genetically distinct species to evolve, probably from the *L. montanum* complex. The var. *intregifolium* does occur in the general area in more moist habitats, and *L. barnebyanum* may have originated from that entity. In searching for the *Lepidium* on other ridges in Indian Creek Canyon, several other similar ecological sites were found, but no other localities of the *L. barnebyanum* are presently known to the writer.

The species name is selected to commemorate the discoverer of the plant, Rupert C. Barneby, the authority on the genus *Astragalus*, and one of the finest collectors of the Intermountain flora.

Literature Cited

Hitchcock, C. L. 1936. The genus *Lepidium* in the United States. Madroño 3:265-320.

———. 1950. On the subspecies of *Lepidium montanum*. Madroño 10:155-158.

Holmgren, A. H. & J. L. Reveal. 1966. Checklist of the vascular plants of the Intermountain region. Intermountain Forest and Range Experiment Station. United States Forest Service, Research Paper INT-32.

Rollins, R. C. 1948. On two perennial caespitose *Lepidium* of western North America. Madroño 9: 162-165.

The Great Basin Naturalist

Founded in 1939 by Vasco M. Tanner

A journal published from one to four times a year by Brigham Young University, Provo, Utah.

Manuscripts: Only original, unpublished manuscripts, pertaining to the Great Basin and the western United States in the main, will be accepted. Manuscripts are subject to the approval of the editor.

Illustrations: All illustrations should be made with a view to having them appear within the limits of the printed page. The illustrations that form a part of an article should accompany the manuscript. All half-tones or zinc etchings to appear in this journal are to be made under the supervision of the editor, and the cost of the cuts is to be borne by the contributor.

Reprints: No reprints are furnished free of charge. A price list for reprints and an order form is sent with the proof.

Subscription: The annual subscription is $2.50 (outside the United States $3.25). Single number, 80 cents.

All correspondence dealing with manuscripts should be addressed to the Editor, Vasco M. Tanner, Great Basin Naturalist, Brigham Young University, Provo, Utah. Other matters such as subscriptions, reprints, exchanges and other business should be addressed to Ernest L. Olson, Chairman of University Publications.

Reprints Schedule of The Great Basin Naturalist

	2 pp.	4 pp.	6 pp.	8 pp.	10 pp.	12 pp.	Each Additional 2 pp.
50 copies	$6.00	$7.00	$8.00	$9.00	$10.00	$11.00	$2.00
100 copies	7.00	8.00	9.00	10.00	11.00	12.00	
200 copies	8.00	9.00	10.00	11.00	12.00	13.00	
300 copies	9.00	10.00	11.00	12.00	13.00	14.00	

Covers: $10.00 for first 100 copies, $4.00 for additional 100 copies.

TABLE OF CONTENTS

New Records and Species of Neotropical Bark Beetles (Scolytidae: Coleoptera), Part II. Stephen L. Wood 119

On the Earthworm Fauna of the Great American Desert and Adjacent Areas. G. E. Gates 142

A New Name for a Utah *Lepidium*. Illustrated. James L. Reveal 177

Volume XXVII, No. 4
December 30, 1967

The Great Basin NATURALIST

Published by
Brigham Young University

The Great Basin Naturalist

Published at Provo, Utah by
Brigham Young University

Volume XXVII December 30, 1967 No. 4

NOTES ON ERIOGONUM - V
A REVISION OF THE ERIOGONUM CORYMBOSUM COMPLEX

James L. Reveal[1]

The *E. corymbosum* complex, as here defined, includes those species of the genus which are woody perennial shrubs or subshrubs with large lanceolate to elliptic or orbicular leaves which are on the lower half of the stems. The *E. microthecum* complex (to be treated in a later paper) differs mainly in having leaves that are narrower and shorter on generally smaller plants.

Eriogonum corymbosum and its related species occur mainly in the Colorado and Green River drainage basins with one outlying species. The region is one of scant rainfall, warm temperatures, and high evaporation. Yet, the scanty vegetation of this region possesses numerous endemic species, and in the genus *Eriogonum*, the endemics are numerous and frequently encountered. The entities occur in a variety of habitats, ranging from hard gumbo clay hills to sandy desert flats and steep mountain slopes. However, rarely are the species of *Eriogonum* the dominant plant in any given site.

Historical Review

The first species to be described in the complex was *Eriogonum corymbosum*. Bentham (1856) named this species from information supplied to him from John Torrey of New York, who had examined the 1845 Frémont collection. In order to show the close relationship between *E. microthecum* and *E. corymbosum*, Bentham proposed a new section, *Corymbosa*. At the same time, Bentham described *E. microthecum* var. *fendlerianum* from information sent to him by Asa Gray of Harvard University. This taxon was later elevated to the species rank by Small (1906). As Torrey & Gray were aware that Bentham was planning to publish *E. corymbosum* in de Candolle's *Prodromus*, they proposed *E. corymbosum* var. *divaricatum*, believing that their variety would appear before Bentham's revision was published. Fortunately, however, the Beckwith Report was delayed until 1857 and the new variety was published nearly a year

1. Department of Botany, Brigham Young University, Provo, Utah.

after Bentham's paper. If the variety had appeared before 1856, the name would have been illegitimate.

Following these initial discoveries and papers, the few specimens that were collected were simply called *E. corymbosum*. In 1895, Marcus E. Jones distinguished the yellow-flowered plants as *E. aureum*. However, in 1902, Aven Nelson raised a question as to the use of the name *E. aureum*, noting that in Bentham's 1856 revision, this name had been cited in synonymy under *E. brevicaule* Nutt. In order to correct this seeming error, Nelson proposed the substitute name, *E. fruticosum*, for *E. aureum*. However, as Bentham was citing the epithet, *E. aureum*, in synonymy, the name had never been published and was still available to Jones. The Nelson substitute name is superfluous.

In a second article, Nelson (1904) described *E. salinum* from a small series of specimens from southern Wyoming. As it will be noted below, this particular collection (*Nelson 3753*) is the closest example found in this study to the Frémont collection which is the type of *E. corymbosum*.

When Jones described *E. aureum*, he also proposed two new varieties, var. *ambiguum* and var. *glutinosum*. The first is a form of *E. microthecum* from the east side of the Sierra Nevada mountains of California. By 1903, Jones recognized that his species, *E. aureum*, was nothing more than a variety of *E. corymbosum* and made the combination *E. corymbosum* var. *glutinosum* for the yellow-flowered form of the species from southern Utah and adjacent northern Arizona.

The elevation of *E. corymbosum* var. *divaricatum* to the species rank by Small (1906) as *E. divergens* saw a corresponding shift of the concept of this taxon away from its type to those specimens which are here called *E. corymbosum* var. *orbiculatum*. At the same time, Rydberg (1912) was modifying the concept of *E. jonesii* S. Wats. of northern Arizona to include specimens of var. *orbiculatum*. Rydberg's concept was subsequently incorporated in his *Flora of the Rocky Mountains and Great Plains* (1917). In Tidestrom's (1925) treatment of the genus, his key is written so that var. *orbiculatum* will key out to *E. nummulare* M. E. Jones. This misapplication has caused the herbarium folders of *E. nummulare* to bulge with a totally unrelated species. It was not until 1936 when Susan G. Stokes, in her monograph of the genus, noted these errors; yet, for the most part, they have persisted.

It has been difficult to comprehend the species alignments of the members of this complex as seen by Stokes. She placed most of the species related to *E. corymbosum* under the more or less unrelated High Plains species, *E. effusum* Nutt. At the same time she referred *E. aureum* to *E. microthecum*. From herbarium studies, several collections have been noted in which Stokes has given two or three different names to duplicates of the same collection. It seems likely that she never truly understood the species involved in either the *E. corymbosum* or *E. microthecum* complexes.

During the course of field work and herbarium studies conducted independently and together with Jack D. Brotherson and others, a number of new taxa related to *Eriogonum corymbosum* were found. The history of these discoveries will be discussed under each entity.

Acknowledgments

I would like to express my appreciation to Dr. Stanley L. Welsh of Brigham Young University who made several suggestions on the various aspects of this paper and the species treated therein. I am indebted to Jack D. Brotherson, formerly a fellow graduate student at Brigham Young University, whose master's thesis on the ecology of two varieties within *Eriogonum corymbosum* has been freely drawn upon, and whose assistance in an early part of this study may be noted below. Field work on this group has been supported both by private financing and by National Science Foundation grants to Dr. Arthur Cronquist of the New York Botanical Garden for the Intermountain Flora Project, a cooperative program between the New York Botanical Garden and Utah State University, and by the Texas Research Foundation. Critical herbarium material has been borrowed through the support of Brigham Young University. Herbarium visits which have been made during this study have been largely supported by Utah State University, the New York Botanical Garden, and the Smithsonian Research Foundation. In this latter case, I would like to thank Conrad V. Morton of the United States National Herbarium who not only assisted me in the preparation of the Latin descriptions, but also freely gave his advice on this and other subjects during a predoctoral internship program at the United States National Herbarium of the Smithsonian Institution from September 1966 to February 1967. This paper has been submitted to the Brigham Young University Botany Department as partial fulfillment of three credits of Doctoral Research given during the Fall Session of 1967-1968. I wish to thank Mrs. Twila Davis Bird whose excellent illustrations are seen below.

The following herbarium collections have been consulted, and to the several curators of herbaria that were visited or who sent loan material for this study, I am most grateful. The abbreviations follow Lanjouw & Stafleu (1964).

A	Arnold Arboretum, Harvard University, Cambridge, Massachusetts.
ARIZ	University of Arizona, Tucson, Arizona.
ASC	Northern Arizona University, Flagstaff, Arizona.
BM	British Museum of Natural History, London, England.
BR	Jardin Botanique de l'État, Bruxelles, Belgium.
BRY	Brigham Young University, Provo, Utah.
CAS	California Academy of Sciences, San Francisco, California.
COLO	University of Colorado, Boulder, Colorado.
DS	Dudley Herbarium, Stanford University, Stanford, California.
GH	Gray Herbarium, Harvard University, Cambridge, Massachusetts.
IDS	Idaho State University, Pocatello, Idaho.
ISC	Iowa State University, Ames, Iowa.
KSC	Kansas State University, Manhattan, Kansas.
LY	Laboratoire de Botanique de la Faculte des Sciences, Lyon, France.

MICH	University of Michigan, Ann Arbor, Michigan.
MO	Missouri Botanical Garden, St. Louis, Missouri.
MONTU	Montana State University, Missoula, Montana.
NY	New York Botanical Garden, Bronx Park, New York.
OKL	Bebb Herbarium, University of Oklahoma, Norman, Oklahoma.
ORE	University of Oregon, Eugene, Oregon.
OSC	Oregon State University, Corvallis, Oregon.
P	Museum National d'Histoire Naturelle, Laboratoire de Phanerogamie, Paris, France.
PH	Academy of Natural Sciences, Philadelphia, Pennsylvania.
POM	Pomona College Herbarium, Rancho Santa Ana Botanic Garden, Claremont, California.
RM	Rocky Mountain Herbarium, University of Wyoming, Laramie, Wyoming.
RSA	Rancho Santa Ana Botanic Garden, Claremont, California.
SD	San Diego Society of Natural History, San Diego, California.
TEX	University of Texas, Austin, Texas.
UC	University of California, Berkeley, California.
UNM	University of New Mexico, Albuquerque, New Mexico.
US	United States National Herbarium, Smithsonian Institution, Washington, D. C.
USFS	Forest Service Herbarium, United States Department of Agriculture, Washington, D. C.
UT	University of Utah, Salt Lake City, Utah.
UTC	Intermountain Herbarium, Utah State University, Logan, Utah.
WIS	University of Wisconsin, Madison, Wisconsin.
WS	Washington State University, Pullman, Washington.
WTU	University of Washington, Seattle, Washington.

Taxonomy

A. Leaf-apices sharply acute, the leaves mostly lanceolate, usually more than 3 cm long.

B. Branches subglabrous to tomentose; involucres tomentose externally.

C. Involucres 2.5-3 mm long; inflorescences with several short branches; perianth white, 3-3.5 mm long, the calyx-segments ± dissimilar; leaves 3-5 cm long, the petioles 3-6 mm long, deciduous on the lower parts of the stems; Mancos Shale east of Wellington, Carbon Co., Utah. 1. *E. lancifolium*

CC. Involucres 3-4 mm long; inflorescences open with few long branches; basal stem leaves usually persistent.

D. Involucres 3.5-4 mm long; perianth white, 3.5-4.5 mm long, the calyx-segments ± dissimilar; leaves 3.5-7 cm long, the petioles 5-10 (18) mm long; Bad Land Cliffs, Duchesne Co., Utah. 2. *E. hylophilum*

DD. Involucres 3-3.5 mm long; perianth yellow, 2.5-3 mm long, the calyx-

segments similar or nearly so; leaves 2.5-4 cm long, the petioles 4-7 mm long; Indian Creek Canyon, Duchesne Co., Utah. 3. *E. duchesnense*

BB. Branches glabrous or floccose; involucres glabrous externally.

C. Leaves tomentose below.

D. Involucres 2-3 mm long; perianth cream to pale yellowish-white, 2-3 mm long, the calyx-segments oblanceolate; inflorescences 1-2 dm long; Dinosaur National Monument area, Uintah Co., Utah. 4. *E. saurinum*

DD. Involucres 2.5-3.5 (4) mm long; perianth white, 2.5-3.5 (4) mm long, the calyx-segments elliptic to oblong; inflorescences up to 1 dm long; southern Colorado and adjacent New Mexico and Texas. 5. *E. fendlerianum*

CC. Leaves as well as the entire plant glabrous throughout; perianth yellow, 3-4 mm long; San Rafael Desert, Emery Co., Utah. 6. *E. smithii*

AA. Leaf-apices mostly rounded, the leaves oblanceolate to lanceolate or elliptic to nearly orbicular, 1-3 (4.5) cm long; southwestern Wyoming and western Colorado to Utah, south to northern Arizona and northwestern New Mexico. 7. *E. corymbosum*

1. *Eriogonum lancifolium* Reveal & Brotherson, spec. nov.

Fruticulus 3.5-5 dm altus, erectus; caules basi per 1.5-3 dm foliosi vel nudi per 5-10 cm; laminae foliorum lanceolatae, 3-5 cm longae, 0.5-1 cm latae, ± revolutae, subtus albo-tomentosae, supra subglabrae et virides, petiolis brevibus, 3-6 mm longis, basi expansa petioli 2 mm lata, tomentosa; caules deorsum tomentosa, sursum subglabri vel parce tomentosi, bracteis 1.5-3 mm longis, linearibus; inflorescentiae ex fasciculis confertis ramulorum erectorum compositae, 6-14 cm longae, subglabrae; involucra turbinata, 2.5-3 mm longa, 1.5-2 mm lata, sessilia, extra tomentosa, intus glabra, 5-lobata, bracteolis oblanceolatis, 1.5-2 mm longis, pedicellis 3-4 mm longis, glabris; perianthia alba, costa brunnea, (2.5) 3-3.5 mm longa, segmentis subsimilibus, exterioribus spathulatis, 3-3.5 mm longis, 1-1.3 mm latis, apice truncato, interioribus oblanceolatis, 2.5-3 mm longis, 0.3-0.6 mm latis; stamina 1.5-4.5 mm longa, filamentis basi glabris, antheris 0.3-0.4 mm longis, oblongis; achaenia brunnea, 2 mm longa.

Shrubby perennials, 3.5-5 dm high, forming densely branched, erect crowns from woody caudices; leaves on the lower half of the

plants, the lowest most often deciduous so that the first leaves are 5-10 cm up the stems, leaf-blades lanceolate, 3-5 cm long, 0.5-1 cm wide, entire or ± crenulate, revolute in some, densely white-tomentose below, less so to subglabrous and green above, the petioles short, 3-6 mm long, floccose-tomentose, the expanding petiole-bases 2 mm wide, subglabrous to sparsely tomentose externally, tomentose internally; lower stems densely tomentose, the branches becoming subglabrous or sparsely tomentose above, 5-12 cm long; bracts ternate, scalelike, 1.5-3 mm long, linear, widening from the acute apices to connate bases, glabrous or subglabrous externally, tomentose internally; inflorescences dense clusters of short, erect, trichotomous, subglabrous branches, 6-14 cm long; involucres sessile, turbinate, 2.5-3 mm long, 1.5-2 mm wide, tomentose externally, glabrous internally, the 5 acute teeth ¼ the length of the tubes, the bractlets narrowly oblanceolate, 1.5-2 mm long with minute capitate marginal cells, the pedicels 3-4 mm long, glabrous; perianth white with brownish (greenish at first) midribs and bases, the outer whorl of segments spathulate with truncate apices, 3-3.5 mm long, 1-1.3 mm wide, the inner segments narrowly oblanceolate, 2.5-3 mm long, 0.3-0.6 mm wide; stamens exserted, 1.5-4.5 mm long, the filaments glabrous at the bases, the anthers 0.3-0.4 mm long, oblong, yellowish-white to reddish; achenes brown, 2 mm long, the ovoid bases gradually tapering to 3-angled beaks. Figure 1.

TYPE. UTAH: Carbon Co. On low, rolling Mancos Shale hills 5 mi E of Wellington, 9 Sep 1967, *James L. Reveal & Gerrit Davidse 957*. Holotype deposited at UTC. Isotypes distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

DISTRIBUTION. Known only from the Mancos Shale hills 3-6 miles east of Wellington and 5.5 miles south of Wellington, Carbon Co., Utah. Map 1. Flowering mainly from August to September.

SPECIMENS EXAMINED. UTAH: Carbon Co., Near Price, *Flowers in 1926* (NY, UT), *in 1927* (BRY, UT, UTC), *in 1928* (BRY, SD, UT); Price, *M. E. Jones 6512* (BM, MO, POM, US); 5 mi E of Wellington, *Moore 661* (BRY, NY, UTC); Price, *S. Stokes s.n.* (UC); 5.5 mi S of Wellington, *Reveal & Davidse 955* (BRY, NY, UTC); 5 mi E of Wellington, *Reveal & Reveal 727* (BRY, NY, UTC); 3 mi E of Wellington, *VanCott & Larsen 87* (UTC); 5 mi E of Wellington, *Welsh & Moore 1836* (BRY, ISC).

This population was first called to my attention by Dr. Stanley L. Welsh of Brigham Young University in 1965. Later, as this study began, a few specimens were seen from the Price-Wellington area that agreed with the Welsh & Moore collection that had been seen before. With the assistance of Brotherson, detailed herbarium studies were carried out in the spring of 1966 which were then followed by field work in 1966 and 1967.

From the herbarium studies, we quickly realized that other taxonomists before us had considered this population to be of some interest. Dr. Seville Flowers of the University of Utah had collected a large series of specimens over a period of three years for study by Stokes. Although both Jones and Stokes had collected the species before, their material was rather limited.

Fig. 1. Habit sketch of *Eriogonum lancifolium* showing the general aspect of the species and a single enlarged segment of the inflorescence with involucres and exserted flowers.

One of the more interesting features of this plant and some of the other members in the complex is the fact that the lower leaves on the stems are deciduous. This condition of early leaf fall gives the plants a rather bare look. In the fall of the year, wilted leaves may be seen as well as the old expanded petiole-bases. However, in the spring, the branches that had leaves the year before were found to lack leaf buds. Also, it should be pointed out that the leaves on this species tend to vary with the conditions of the year. In poor years the leaves tend to be longer and narrower and decidedly more acute, and the inflorescences are not as densely branched. Thus the type collection cited above which was collected in a good year has a large, dense inflorescence with somewhat shorter leaves than most of the specimens cited in the list of exsiccatae.

On most of the early collections, the location data were given simply as "Price" or "Near Price." Attempts to find this species near the Price area have been without success, and it is thus suggested that all of the collections came from the Wellington area, and the use of "Price" was simply to indicate the largest city in this general area.

The relationship of *E. lancifolium* to the other members of the complex is not certain. Its most closely related species seems to be *E. saurinum*, but the pubescence is not at all similar. At the same time, the Wellington Buckwheat approaches *E. hylophilum* in the branching pattern of the basal portions of the plants, but the inflorescences differ, and *E. hylophilum* has leaves which are shaped differently and not deciduous.

2. *Eriogonum hylophilum* Reveal & Brotherson, spec. nov.

Fruticulus 2.5-4 dm altus; caules basi per 1-1.5 dm foliosi; laminae foliorum lineari-lanceolatae vel lanceolatae, 3.5-7 cm longae, 3-6 (8) mm latae, subtus albo-tomentosae, supra viridi-tomentosae, petiolis longis, 5-10 (18) mm longis, basi expansa petioli 2-3 (3.5) mm lata, tomentosa; caules ubique tomentosi, 1-2.5 dm longi, bracteis superioribus 2-3 mm longis, inferioribus ± foliaceis, 3-20 mm longis; inflorescentiae ex fasciculis nonnulis brevibus densis ramulorum compositae, tomentosae, 3-8 cm longae; involucra turbinata, 3.5-4 mm longa, 2.5-3 mm lata, extra tomentosa, intus glabra, 5-6 lobata, bracteolis oblanceolatis, 3.5-5 mm longis, pedicellis 3.5-5 mm longis, glabris; perianthia alba, costa viridi, (3) 3.5-4 (4.5) mm longa, extra glabra, intus minute glandulosa, segmentis subsimilibus, exterioribus spathulatis, 1.3-1.7 (2) mm latis, interioribus oblanceolatis, 0.6-0.9 (1.2) mm latis; stamina 2-3 (3.5) mm longa, filamentis basi pilosis, antheris 0.3-0.5 mm longis, oblongis; achaenia brunnea, 2.5-3 mm longa.

Subshrubby perennials, 2.5-4 dm high, forming open, branched and erect crowns from woody caudices; leaves on the lower fourth of the plants, persistent, linear-lanceolate to lanceolate, 3.5-7 cm long, 3-6 (8) mm wide, densely white-tomentose below, less so and green above, the margins entire and ± revolute or rarely crenulate, the

petioles long, 5-10 (18) mm long, tomentose, the expanding petiole-bases 2-3 (3.5) mm wide, tomentose on both surfaces; stems tomentose, 1-2.5 dm long; bracts ternate, scalelike and triangular above, 2-3 mm long, becoming ± foliaceous and up to 2 cm long below, widening from acute apices to connate bases; inflorescences open, the branches short and stout, 3-8 cm long, tomentose; involucres sessile with 1-3 per node, turbinate, 3.5-4 mm long, 2.5-3 mm wide, tomentose externally, glabrous internally, the 5-6-lobes less than ¼ the length of the tubes, the bractlets oblanceolate, 3.5-5 mm long, hirsutulous with long marginal cells, the pedicels 3.5-5 mm long, glabrous; perianth white with greenish midribs, (3) 3.5-4 (4.5) mm long, glabrous without, minutely glandular along the midribs within, the calyx-segments ± dissimilar, the outer whorl of segments spathulate with acute apices, 1.3-1.7 (2) mm wide, the inner segments oblanceolate, 0.6-0.9 (1.2) mm wide; stamens included, 2-3 (3.5) mm long, the filaments pilose basally, the anthers greenish-white, 0.3-0.5 mm long, oblong; achenes brown, 2.5-3 mm long, the ovoid bases tapering to 3-angled, retrorsely roughened, beaks. Figure 2.

TYPE. UTAH: Duchesne Co. Along Utah highway 53 (the Wellington-Myton Road) in Gate Canyon, 2.7 mi SW of the summit of the Bad Land Cliffs, Sec. 20, T. 11 S., R. 15 E., elevation 6500 feet, 15 Aug 1966, *Noel H. Holmgren & James L. Reveal 3017*. Holotype deposited at UTC. Isotypes distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

DISTRIBUTION. Locally common on the Bad Land Cliffs near Gate Canyon, Duchesne Co., Utah. Map 1. Flowering from late July to September.

SPECIMENS EXAMINED. UTAH: Duchesne Co., Summit of the Bad Land Cliffs, along Utah highway 53, *Holmgren, Reveal, & LaFrance 2386* (ARIZ, BRY, CAS, DS, GH, KANS, MO, NY, OKL, OSC, RM, RSA, UC, US, UT, UTC, WIS).

This distinctive species has apparently gone unnoticed by the several taxonomists who have passed over the summit of the road between Wellington and Myton. Actually, as far as *Eriogonum* is concerned, several of the late season entities are poorly known, and suspecting that a large and relatively unknown flora might exist in the Intermountain Region in the fall, several collecting trips have been made during this period. As this paper and others (Reveal, in press a, b) demonstrate, the rewards from this late season collecting have been rich.

Eriogonum hylophilum was first discovered in 1965, but at that time it was thought to be *E. corymbosum*. As the nature of *E. corymbosum* was determined, it was possible to see that this material from the Bad Land Cliffs was distinct. The population extends nearly five miles down Gate Canyon on the Wellington side of the summit, but less than half of a mile on the Myton side. Toward the west, the species was found to extend less than a mile, but its eastward limits have not been determined.

In Gate Canyon, *E. hylophilum* occurs as scattered plants on *Artemisia* hillsides in the Pinyon-Juniper belt. The species is com-

Map 1. Distribution in eastern Utah of *Eriogonum lancifolium* (L); *E. hylophilum* (H); *E. duchesnense* (D); *E. saurinum* (S); and *E. smithii* (SM).

monly found with *E. corymbosum* var. *erectum*, and in the field, the two are easily distinguished. However, the separation of *E. hylophilum* and *E. lancifolium* is not as readily apparent, especially in the herbarium. These two differ in several technical characteristics such as perianth size and shape, involucre characters, and the nature of the inflorescences and growth patterns, yet they seem to be rather

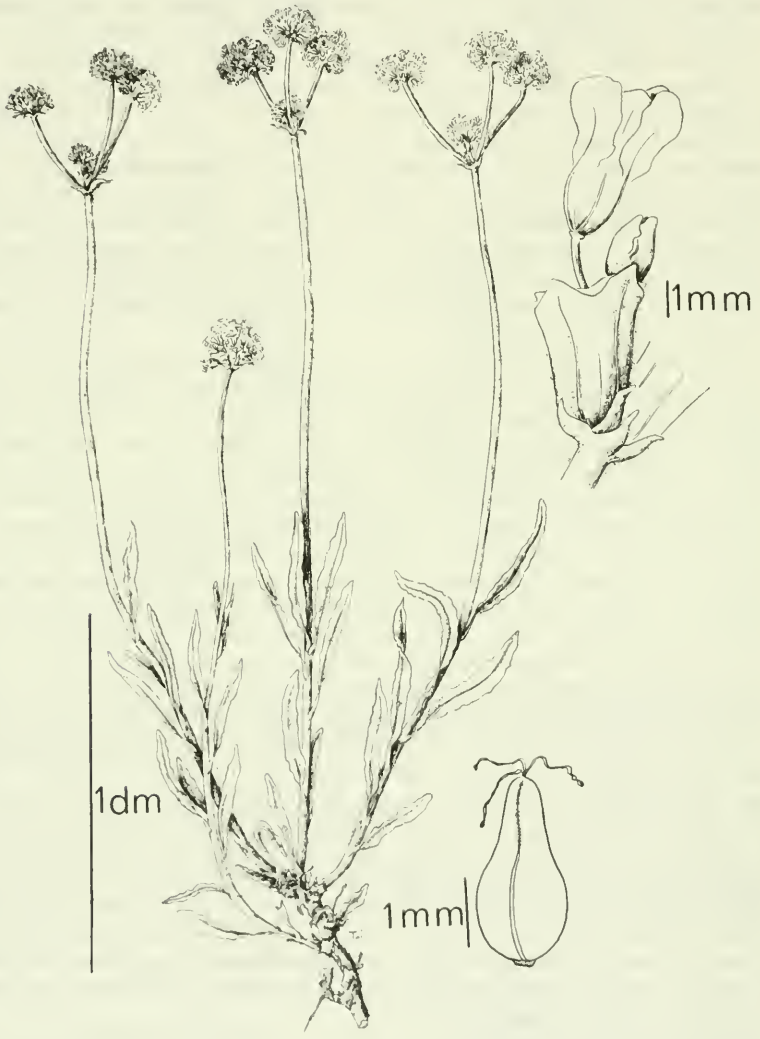


Fig. 2. Habit sketch of *Eriogonum hylophilum* showing the generally stout erect stems and the capitate or short-rayed inflorescences of clustered involucres, with an enlarged involucre and flowers, and of a single achene.

closely related. Actually however, the species that is probably most closely related to *E. hylophilum* is *E. duchesnense.*

3. *Eriogonum duchesnense* Reveal, spec. nov.

Fruticulus 2-3.5 dm altus; caules basi per 1-1.5 dm foliosi; laminae foliorum lanceolatae vel spathulatae, 2.5-4 cm longae, 0.5-1 cm latae, subtus albo-tomentosae, supra subglabrae et virides, petiolis brevibus, 4-7 mm longis, basi expansa petioli 2 mm lata, extra tomentosa, intus subglabra vel glabra; caules deorsum tomentosi, ramis 1-1.5 dm longis; bracteae foliaceae, 3-10 mm longae, lineares vel lanceolatae, tomentosae; inflorescentiae ex fasciculis nonnullis brevibus densis ramulorum compositae, tomentosae, (3) 5-10 cm longae; involucra turbinata, 3-3.5 mm longa, 2-2.5 mm lata, sessilia, extra tomentosa, intus glabra, 5-lobata, bracteolis oblanceolatis, 2-2.5 mm longis, pedicellis 3-4.5 mm longis, glabris; perianthia flava, 2.5-3 mm longa, extra glabra, intus minute pilosa vel glandulosa, segmentis subsimilibus, elongato-obcordatis vel oblanceolatis, exterioribus 1.5 mm latis, interioribus 1-1.3 mm latis; stamina 1.5-2 mm longa, filamentis basi pilosis, antheris 0.3-0.4 mm longis, oblongis; achaenia brunnea, 2-3 mm longa.

Subshrubby perennials, 2-3.5 dm high, forming open crowns from woody caudices; leaves on the lower third of the plant, persistent, lanceolate to spathulate, 2.5-4 cm long, 0.5-1 cm wide, densely white-tomentose below, subglabrous and green above, the petioles short, 4-7 mm long, subglabrous, the petiole-bases 2 mm wide, tomentose to subglabrous externally, subglabrous to glabrous internally; branches tomentose, densely so among the leaves, less so above, the branches 1-1.5 dm long; bracts ternate, ± foliaceous, 3-10 mm long, linear to lanceolate, widening from the acute apices to connate bases, tomentose within and without; inflorescences open and compoundly divided, the short, stout branches rather clustered, tomentose, (3) 5-10 cm long; involucres sessile with 1-3 per node, turbinate, 3-3.5 mm long, 2-2.5 mm wide, tomentose externally, glabrous internally, the 5 acute teeth nearly ½ the length of the tubes, the bractlets oblanceolate, 2-2.5 mm long, hirsutulous with numerous long marginal cells, the pedicels 3-4.5 mm long, glabrous; perianth yellow, 2.5-3 mm long, glabrous without, with few scattered hyaline hairs or minute glands within, the calyx-segments ± similar, the outer whorl of segments elongate-obcordate, 1.5 mm wide, the inner segments slightly narrower, 1-1.3 mm wide; stamens included, 1.5-2 mm long, the filaments pilose basally, the anthers 0.3-0.4 mm long, greenish-yellow, oblong; achenes brown, 2-3 mm long, the ovoid bases tapering to short 3-angled beaks, ridged with the distinct margins extending down the entire length of the fruit, roughened with retrorse hairs along the margins. Figure 3.

Type. utah: Duchesne Co. Ca. 24 mi SW of Duchesne along Utah highway 33, in Indian Creek Canyon, 0.7 mi below the Indian Creek Canyon Guard Station on steep clay banks, sec. 28, T. 10 S., R. 7 W., elevation 7800 feet, 2 Sep 1964, *James L. Reveal 678.* Holotype

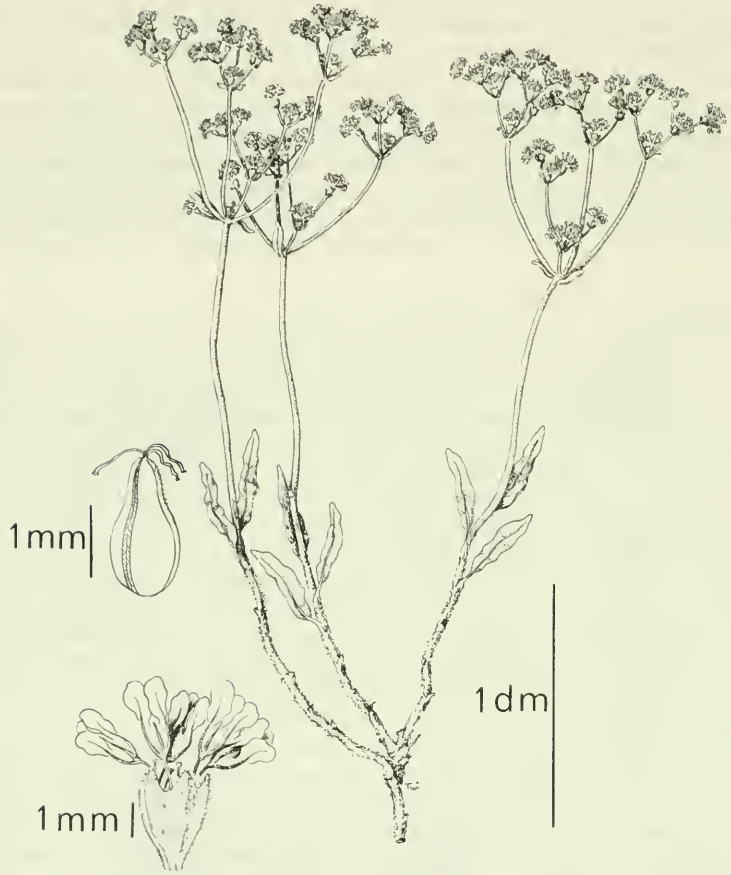


Fig. 3. Habit sketch of *Eriogonum duchesnense* showing the erect stems and compound inflorescences with a single enlarged involucre with several flowers and a single involucre.

deposited at UTC. Isotypes distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

DISTRIBUTION. Infrequent and rare in Indian Creek Canyon, Duchesne Co., Utah. Map 1. Flowering mainly in August and September.

SPECIMENS EXAMINED. UTAH: Duchesne Co., 5 mi N of the summit of Indian Creek Canyon, *Maguire & Richards 13287* (GH, UC, UTC).

Eriogonum duchesnense has been a puzzling plant to study. When this species was first discovered by me a large collection was made, photographs taken, and its distribution in the canyon was studied. However, since 1964, the State of Utah has rebuilt the upper part of the highway in the canyon, and for the past three years not a

single plant has been found. Thus, the description of the entity is based on the material collected by Maguire and Richards, and on the type collection.

This species seems to be most closely related to *E. hylophilum*, from which it may have been derived. As noted in the key, the two differ in several characteristics of the involucres, calyx-segments, and leaves. Yet, the two are rather similar in habit, growth patterns, and ecology, although when comparing the various collections in the herbarium, these similarities are lost. The most readily discernible feature separating the two species is the flower color.

4. *Eriogonum saurinum* Reveal, spec. nov.

Fruticulus 3-5 dm altus; caules basi per 1-1.5 dm foliosi vel nudi per 5-10 cm; laminae foliorum lanceolatae, 3-6 cm longae, 4-8 mm latae, subtus albo-tomentosae, supra subglabrae et virides, petiolis 5-10 mm longis, basi expansa petioli 2-2.5 mm lata, tomentosa; caules ubique glabri, (1.5) 2-3.5 dm longi, bracteis superioribus 1 mm longis, linearis, inferioribus foliaceis, 1-3 cm longis; inflorescentiae ex fasciculis apertis ramulorum expansorum compositae, 1-2 dm longae; involucra turbinata, 2-3 mm longa, 1.5-2 mm lata, subsessilia vel sessilia, glabra, 5-lobata, bracteolis linearis, 2-3 mm longis, pedicellis 2.5-3.5 mm longis, glabris; perianthia eburnea, costa brunnescena, 2-3 mm longa, segmentis subsimilibus, exterioribus oblanceolatis, 3-3.5 mm longis, 0.7-0.9 mm latis, apice rotundo, interioribus anguste oblanceolatis, 2.5-3 mm longis, 0.5-0.7 mm latis; stamina 2.5-4 mm longa, filamentis basi pilosis, antheris 0.3-0.4 mm longis, flavis; achaenia brunnea, 2.5-3 mm longa.

Shrubby perennials, 3-5 dm high with open and spreading crowns from branching woody caudices; leaves on the lower half of the plants, these often becoming deciduous on the lower 5-10 cm of the stems, the leaf-blades 3-6 cm long, 4-8 mm wide, lanceolate, densely white-tomentose below, subglabrous and green above, the petioles 5-10 mm long, floccose-tomentose, the petioles bases 2-2.5 mm wide, tomentose on both surfaces; lower stems tomentose only among the leaves, becoming green and glabrous above, (1.5) 2-3.5 dm long; bracts ternate, scalelike and 1 mm long above, becoming foliaceous and up to 3 cm long below, these similar to the leaves and usually only at the first node, the acute apices widening to connate bases, glabrous externally, tomentose internally; inflorescences cymose, spreading, the open branches mostly trichotomous, 1-2 dm long; involucres sessile or subsessile, not clustered, turbinate, 2-3 mm long, 1.5-2 mm wide, glabrous, the 5 acute lobes less than ¼ the length of the tubes, the bractlets linear, 2-3 mm long, the pedicels 2.5-3.5 mm long, glabrous; perianth cream-white to pale yellowish-white with light tan midribs and bases, 2-3 mm long, glabrous except for minute glandular hairs within along the midribs, the calyx-segments ± similar, the outer whorl of segments oblanceolate with rounded apices, 3-3.5 mm long, 0.7-0.9 mm wide, the inner segments narrower and shorter, 2.5-3 mm long, 0.5-0.7 mm wide; stamens 2.5-4 mm long,

the filaments pilose basally, the anthers 0.3-0.4 mm long, pale yellow; achenes light brown, 2.5-3 mm long, the subglobose bases tapering to 3-angled beaks. Figure 4.

TYPE. UTAH: Uintah Co. Along the Island Park Road, 10 mi E of Vernal along Brush Creek on steep hillsides on the ridges of Mowry Shale, sec. 1, T. 1 N., R. 22 E., elevation 5200 feet, 15 Aug 1966, *Noel H. Holmgren & James L. Reveal 3019*. Holotype deposited at UTC. Isotypes distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

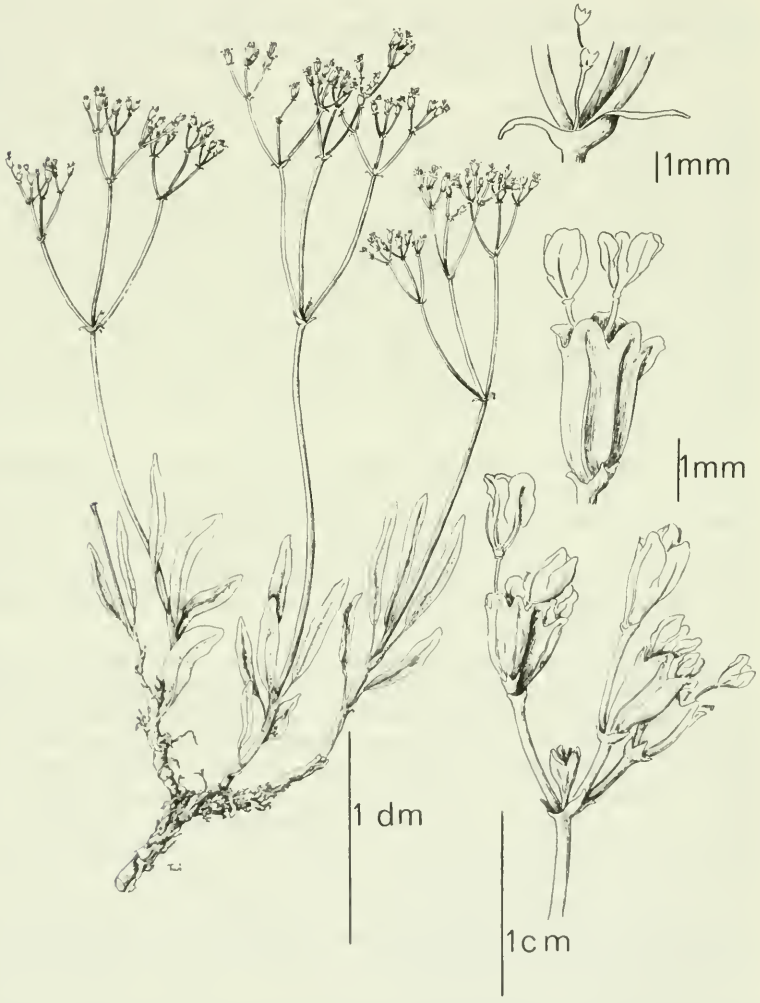


Fig. 4. Habit sketch of *Eriogonum saurinum* showing the general aspect of the species with enlarged drawings of the inflorescence, a single involucre with two exserted flowers, and the bracts subtending the inflorescence.

Distribution. Locally common in the Dinosaur National Monument area where it is highly restricted to the narrow band of Mowry Shale, Uintah Co., Utah. Map 1. Flowering from late July to September.

Specimens Examined. UTAH: Uintah Co., Diamond Valley, *Andrews & Noble s.n.* (UTC); 6.5 mi N of Vernal, near Steinaker Res., *Reveal 674* (ARIZ, BRY, CAS, DS, GH, KANS, MO, NY, OKL, OSC, RM, RSA, TEX, UC, US, UT, UTC, WIS); near Dinosaur N. M., *Welsh 366* (BRY); Island Park, *Welsh 517* (BRY, UTC); between Island Park and Vernal, *Wolf & Dever 5261* (UTC).

Eriogonum saurinum is an unusual species from an ecological standpoint. Throughout the area surrounding the Dinosaur National Monument as well as in the Monument itself, there is a narrow, often upright, band of acidic Mowry Shale which has a pH often less than 5 (Hanson, 1962; Brotherson, 1967). On the soil derived from the Mowry Shale, as well as the band itself, *E. saurinum* is found. When standing on some prominence, it is possible to see this resistant shale standing out as it often forms the backbones of the low hills. On these hills, and especially along their ridges, *E. saurinum* is abundant. In fact, when one views the ridges from the side, they appear frilled with the green branches of the *Eriogonum*. When the Mowry Shale is not exposed, the buckwheat is missing. The Dinosaur Buckwheat is rarely more than 10 feet away from the shale. Those plants which grow along side the layer are not as robust as those closer or directly upon the shale. Welsh (1957) made several observations on the occurrence of this plant, as did Brotherson (per. comm.), and they both confirm the strict adherence of this species to Mowry Shale.

In the Dinosaur National Monument, endemics are not unusual (Welsh & Christensen, 1957; Holmgren, 1962). One of the more interesting of the endemics is *Astragalus chloöides* Barneby. In many respects the genus *Astragalus* is similar to *Eriogonum* in its features of endemism. Like *E. saurinum*, *A. chloöides* is highly restricted to a single formation (Entrada Sandstone) and has not been found off of this specific soil type.

For several years, *E. saurinum* has been incorrectly called *E. lonchophyllum* Torr. & Gray. However, this latter species is known only from northern New Mexico and southern Colorado, and is actually a member of the section associated with *E. brevicaule* Nutt. The two species differ in several characteristics. The leaves of both species are lanceolate, but those of *E. saurinum* are less than 6 cm long, while the leaves of *E. lonchophyllum* often range from 5-10 cm long. The involucres and perianth of *E. lonchophyllum* are both 3-4 mm long, while those of *E. saurinum* are only 2-3 mm long.

The distinction between *E. saurinum* and *E. corymbosum* is most striking in the field. As Brotherson (1967) has shown, they occupy two different soil types, with *E. saurinum* being on the acid soils and *E. corymbosum* normally on the basic soils, with notable exceptions (Welsh 1957). In the herbarium, the two may be distinguished by the glabrous stems and open, few branched crowns of *E. saurinum*,

while the other species is tomentose and the crowns are decidedly more densely branched.

5. *Eriogonum fendlerianum* (Benth. in DC.) Small, Bull. Torrey Bot. Club 33: 55. 1906.

E. microthecum Nutt. var. ? *fendlerianum* Benth. in DC., Prodr. 14: 18. 1856. *E. effusum* Nutt. ssp. *fendlerianum* S. Stokes, Gen. Eriog. 79. 1936. *E. corymbosum* Benth. in DC. var. *fendlerianum* attributed to S. Wats. by S. Stokes, Gen. Eriog. 79. 1936, in synonymy.

E. ainslei Woot. & Standl., Contr. U. S. Nat. Herb. 16: 117. 1913. *E. effusum* Nutt. ssp. *ainslei* S. Stokes, Gen. Eriog. 79. 1936. (TYPE: Cimarron, Colfax Co., New Mexico. 20 Sep 1909. *C. N. Ainslie s n.* Holotype: US! Isotypes: US!)

Subshrubby to shrubby perennials, (1) 1.5-4 (5) dm high, forming open and spreading crowns of few to several branches from woody caudices; leaves on the lower half to two-thirds of the plants, the leaf-blades lanceolate to elliptic, 1.5-4 (5) cm long, (0.3) 0.5-2 cm wide, entire or crenulate along the margins, densely white-tomentose below, subglabrous to glabrous and green above, the petioles long, 5-20 mm long, subglabrous on the upper surface, tomentose on the lower surface, revolute, the expanding petiole-bases 2-3 mm wide, glabrous or tomentose externally, tomentose internally; lower stems densely tomentose among the leaves, the branches becoming glabrous or rarely floccose above, 3-15 (20) cm long; bracts ternate, mostly scalelike, 1-2.5 mm long, linear, widening from acute apices to connate bases, glabrous or subglabrous without, densely tomentose within; inflorescences open, mostly trichotomous, 2-10 cm long; involucres sessile, peduncled in the forks of the branches 1-7 mm long, involucres turbinate to turbinate-campanulate, 2.5-3.5 (4) mm long, 1.5-3.5 mm wide, glabrous or rarely subglabrous externally, often pilose at the throat of the tubes internally, becoming glabrous below, the 5 acute lobes less than ¼ the length of the tubes, the bractlets linear-oblanceolate, 2-3 mm long, hirsutulous with minute marginal cells, the pedicels 3-4.5 (5) mm long, glabrous; perianth white with brownish midribs and bases, 2.5-3.5 (4) mm long, the calyx-segments similar or nearly so, the outer whorl of segments elliptical to oblong, the inner segments slightly narrower and shorter; stamens 2-4 mm long, the filaments pilose basally, the anthers 0.4-0.5 mm long, oblong; achenes brown, 2-2.5 mm long, the ovoid bases gradually tapering to 3-angled beaks. Figure 5.

TYPE. NEW MEXICO: Toas Co. Red River at Rock Creek, 1847. *Fendler 767.* Holotype deposited at GH! Isotypes: BM, GH, MO, NY!

DISTRIBUTION. Southwestern Colorado eastward to eastern Colorado and adjacent northeastern New Mexico, and (apparently) in western Texas. Map 2. Flowering from July to early September.

REPRESENTATIVE SPECIMENS. COLORADO: El Paso Co., Colorado Spr., *M. E. Jones s.n.* (US); Fountain, *Redfield 327* (NY). Fremont Co., Cañon City, *Brande-*

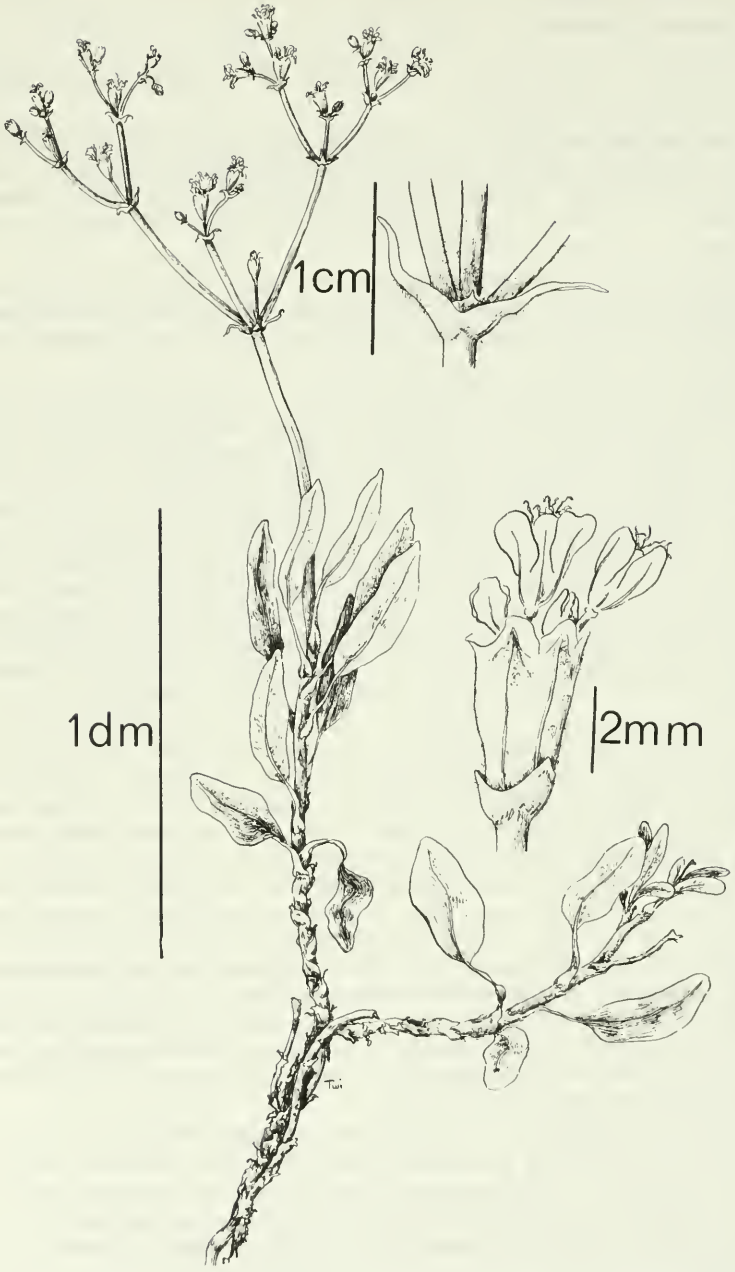
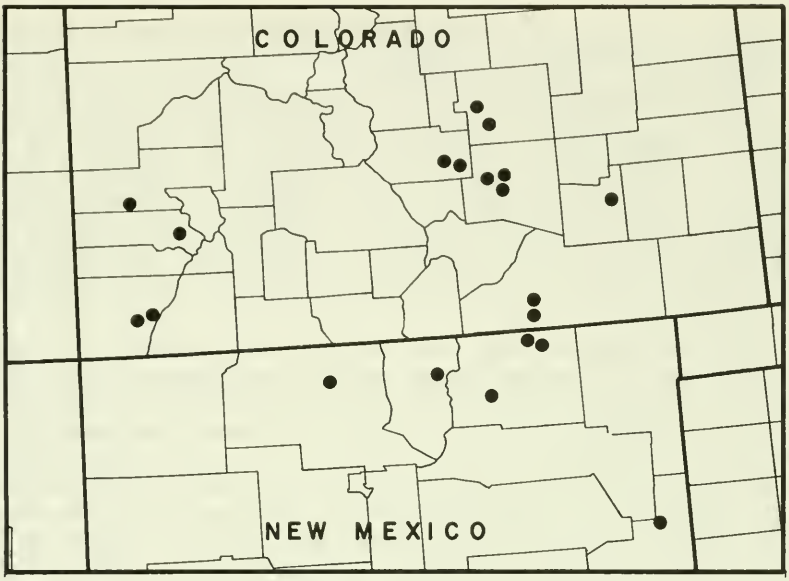


Fig. 5. Habit sketch of *Eriogonum fendlerianum* showing the stout stems and inflorescence with enlarged drawings of a single involucre with exserted flowers and the bracts subtending the inflorescence.



Map 2. Distribution of *Eriogonum fendlerianum.*

gee 327 (NY, UC); Cañon City, *M. E. Jones 788* (BM, BR, CAS, NY, POM, US, UTC); 3 mi S of Florence, *Penland 4621* (COLO); 6 mi E of Cañon City, *Reveal & Davidse 871* (BRY, NY, UTC); 12 mi E of Cañon City, *Waterfall 10868* (ARIZ, COLO, OKL, UTC). Las Animas Co., 10 mi SE of Trinidad, *Rollins 1860* (DS, GH, MO, MONTU, NY, US, UTC, WS). Montezuma Co., Mancos, *Eastwood in 1890* (COLO), *in 1892* (MO, UC); North Rim of Mesa Verde, *Frauke s.n.* (RM); Mesa Verde, *Maguire 12701* (NY, OKL, UTC). Montrose Co., 10 mi SW of Crawford, *Rollins 1961* (DS, GH); Coventry, *Walker 540* (GH, MO, NY, POM, US, WS). Otero Co., La Junta, *Rose & Fitch 17165* (NY, US). Pueblo Co., Pueblo, *Greene in 1874* (GH, ISC, NY, PH, US), *in 1889* (UC); 18 mi W of Pueblo, *Waterfall 10856* (ARIZ, COLO, OKL, UTC). San Miguel Co., 10 mi W of Telluride, *Maguire 12775* (GH, UTC). NEW MEXICO: Colfax Co., Cimmaron, *Ainslie s.n.* (US); Raton Mts., *Bele 50* (GH); near Raton, *Rose & Fitch 17554* (NY, US); 6 mi SW of Raton, *Reveal & Davidse 873* (BRY, NY, UTC); 12 mi SE of Raton, *Turner & Melchert 4827* (TEX); 8 mi SE of Raton, *Waterfall 12025* (OKL, TEX). Quay Co., Logan, *Fisher 92* (MO, US). Rio Arriba Co., near Tierra Amarilla, *Wooton s.n.* (US). TEXAS: Without definite location. *Rammel s.n.* (US).

Eriogonum fendlerianum occurs in two forms, both of which have been named. The low, spreading form was named *E. ainslei* and is found mainly in southeastern Colorado and on the plains of northeastern New Mexico. To the west is the larger and somewhat more erect form which is represented by the type of *E. fendlerianum.* In southwestern Colorado, this kind of plant is at its extreme in stature. Nevertheless, in studying the plants in the field, these variants are easily bridged when intermediate geographical areas are visited. South of Raton, New Mexico, both forms may be seen growing together. At least in that area, the small form (*E. ainslei*), seems to be only younger plants of the larger form (*E. fendlerianum*). As I

can see no morphological grounds for maintaining both as species, *E. ainslei* is now reduced to synonymy.

In the Stokes treatment (1936), she recognized *E. effusum* Nutt. ssp. *salicinum* (Greene) S. Stokes as a form related to what is here called *E. fendlerianum*. However, in visiting the type area of *E. salicinum* at the Black Canyon of the Gunnison, it was found to be the same kind of plant that has been called *E. scoparium* Small. *Eriogonum salicinum*, which includes *E. scoparium* and possibly *E. tristictum* Small, seems to be closely related to *E. lonchophyllum* Torr. & Gray. However, this group of species is in need of considerable critical study.

Eriogonum fendlerianum is seemingly closely related to the more northern species described above, yet the exact nature of this suggested relationship, if any, has not been determined. From the aspect of gross morphology, this species resembles *E. saurinum*, mainly in the open crown, various features of the involucres and perianth, and usually in its ecology. At the present time, however, it seems that *E. fendlerianum* is actually closer to *E. corymbosum*, and the similarities with the Dinosaur Buckwheat are presently thought to be parallel rather than an indication of close relationship. The plants from the Mesa Verde area are exceedingly large and robust, and in the leaf features approaches certain specimens which are now tenuously assigned to *E. corymbosum* var. *orbiculatum* from southeastern Utah. The *Reveal 687* from 15 miles south of the La Sal Junction resembles the Mesa Verde plants closely, but differs in the stem pubescence, and size of the involucres and perianth. The area from the La Sal Junction southeastward to the Mesa Verde has had little botanizing in the fall of the year, and until some detailed field observations of *E. fendlerianum* can be made, the several questions of relationships must remain unanswered.

6. *Eriogonum smithii* Reveal, spec. nov.

Fruticulus (3) 4-8 dm altus, omnino viridis et glabris; caules basi per 1.5-4 (5) dm foliosi; laminae foliorum ellipticae, 2.5-4.5 cm longae, 6-10 mm latae, ± revolutae, petiolis 3-5 mm longis, basi expansa petioli 2.5-3.5 mm lata; bracteae 1-1.5 mm longae; inflorescentiae cymosae, 2-2.5 cm longae, ± compactae; involucra turbinata (2.5) 3-3.5 mm longa, 2-2.5 mm lata, glabra margine ciliata excepta, 5-lobata, bracteolis lineari-oblanceolatis, 1.5-2.5 mm longis, pedicellis 3-3.5 mm longis; perianthia lutea, 3-4 mm longae, glabra, segmentis subsimilibus, exterioribus obovatis, 1.5-2 mm latis, interioribus oblanceolatis, 1-1.5 mm latis; stamina 2-5 (7) mm longa, filamentis basi pilosis, antheris flavis, 0.4-0.5 mm longis; achaenia brunnea. 3 mm longa.

Perennial shrubs, (3) 4-8 dm high and up to 2 m across, with many branches arising from woody caudices, the stems woody only at the base, becoming herbaceous above, the plants entirely glabrous throughout except for the axils of the leaves which bear the leaf-bud primordia, these sparsely pubescent; leaves decurrent and widely

separated along the lower ⅔ of the plants, the lower leaves often deciduous so that the first leaves are 5-15 cm or more up the stems, the leaf-blades narrowly elliptical, 2.5-4.5 cm long, 6-10 mm wide, ± revolute, the leaf-margins always thicker than the blades, bright green, the petioles short, 3-5 mm long with the expanding petiole-bases 2.5-3.5 mm wide, glabrous and brown or tan externally, densely or sparsely white-tomentose internally; bracts ternate, scalelike, 1-1.5 mm long, linear to triangular, the acute apices widening to connate bases; inflorescences open, cymose, mostly trichotomously branched throughout, 2-25 cm long, the branches short and somewhat compact, bright green; involucres sessile, turbinate, (2.5) 3-3.5 mm long, 2-2.5 mm wide, glabrous, finely ciliated in the throat in some, sharply angled with 5 acute teeth, these less than ¼ the length of the tubes, the lobes of the teeth often with membranaceous margins, the bractlets 2 per pedicel, linear-oblanceolate, 1.5-2.5 mm long, hirsutulous with short acute marginal cells, the pedicels 3-3.5 mm long, glabrous; perianth yellow, 3-4 mm long, glabrous without, microscopically glandular along the midribs within, the calyx-segments subsimilar, the outer whorl of segments obovate, 1.5-2 mm wide, the inner segments oblanceolate, 1-1.5 mm wide; stamens 2-5 (7) mm long, the filaments pilose basally, the anthers yellow, 0.4-0.5 mm long, oblong; achenes brown, lance-ovoid, 3 mm long, the ovoid bases tapering to roughened 3-angled beaks. Figure 6.

TYPE. UTAH: Emery Co. On the east side of a low summit along a sandy desert road between Little Flat Top and Big Flat Top, San Rafael Desert, about 10 mi SE of Utah highway 24 from the turnoff which is 0.5 mi S of the Goblin Valley turnoff, sec. 22, T. 26 S., R. 13 E., elevation 5500 feet, 14 Aug 1966, *Noel H. Holmgren & James L. Reveal 3012.* Holotype deposited at UTC. Isotypes distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

DISTRIBUTION. Known only from the north and east side of Big Flat Top and near Little Flat Top, San Rafael Desert, Emery Co., Utah. Map 1. Flowering from late July to September.

SPECIMENS EXAMINED. UTAH: Emery Co., E of Big Flat Top, *Reveal & Davidse 950* (BRY, NY, UTC); N of Big Flat Top, *Reveal & Davidse 951* (BRY, NY, UTC); between Big Flat Top and Little Flat Top, *A. D. Smith s.n.* (BRY, CAS, NY, UTC).

Eriogonum smithii can be instantly recognized by its bright green color, its bright yellow flowers, and its almost total lack of pubescence, the latter feature not found in any other perennial species in the genus. Its relationship to other species in the genus has been determined on the basis of its overall morphology. It is believed that *E. smithii* is related to *E. corymbosum.*

The site where the type of *E. smithii* was collected is in a small circular basin that is surrounded on two-thirds of its sides by steep red sandstone cliffs of the Summerville Formation. The remaining side is the edge of the San Rafael Desert which is composed of red Entrada "blowsand" in this area. In the basin, the plants occur mainly on the floor where there seems to be a high selenium content.

Fig. 6. Habit sketch of *Eriogonum smithii* showing the erect leaves and compound inflorescences with enlarged drawings of the petiole base, a cross section of a leaf, and involucres with exserted flowers.

However, the largest plants occupy the upper edges of the basin and especially so on the sandy desert floor east of Little Flat Top and thus north and east of Big Flat Top. In this area the plants are on the edges of small outwash areas where the infrequent rain water has formed small gullies and rivlets. Further to the east, on a small mesa east of Big Flat Top, the plants of *E. smithii* are much smaller and more sparsely branched than elsewhere. I have seen this species up to 5 miles east of Little Flat Top, but how much further to the east the species extends has not been determined.

The branching habit of *E. smithii* reflects most clearly the kind of branching habit found in this group. In the axis of one of the leaves is a stem bud. This bud is often one decimeter or more up the branch. In the spring, the bud produces a stem which in turn, of course, has a stem bud. However, as the stem buds are always below the inflorescence, the new stem with its greater weight causes the old stem to become nearly prone and thus widely spreading. The new stems are erect or only slightly spreading outwardly to conform with the overall shape of the bush. The old inflorescence, that is, the one produced the previous year, is now brown and dried and sticks out beyond the new stem. In *E. corybosum* var. *orbiculatum*, the old inflorescences may be easily seen. Thus, as the plants grow, the distance between the root and the flowering stems gradually increases. In the sandy areas particularly, the older stems and branches are buried in rounded mounds of sand.

It is a privilege to follow the suggestion of Arthur H. Holmgren, who called this plant to my attention, by naming this species in honor of Dr. Arthur D. Smith, professor in the Range Sciences Department and a member of the Utah State Fish and Game Department. Long recognized as an authority on range management practices in the western United States, he has been a diligent plant collector of Great Basin and Intermountain plants for over thirty years.

7. *Eriogonum corymbosum* Benth. in DC., Prodr. 14: 17. 1856.

Subshrubby and shrubby perennials, (2) 3-8 (12) dm high, forming erect to hemispherical crowns of few to many branches from branching, woody, caudices; leaves mainly on the lower half of the plants, often extending up to the base of the inflorescences, the leaf-blades oblanceolate to lanceolate or elliptic to nearly orbicular, 1-3 (4.5) cm long, (0.3) 0.5-3 (3.5) cm wide, entire or crenulate, densely white-tomentose on both surfaces, or often becoming less pubescent to subglabrous or nearly glabrous and green above, the petioles short to long, 2-15 mm long, subglabrous to tomentose, the petiole-bases 1.5-3 mm wide, subglabrous to tomentose externally, densely tomentose internally; stems tomentose or subglabrous to (rarely) glabrous, (8) 10-20 (25) cm long; bracts ternate, scalelike, 1-3 mm long, triangular, widening from acute apices to connate bases, tomentose or glabrous externally, tomentose internally, the bracts of the lower nodes of the inflorescences occasionally foliaceous and up to 2.5 cm long, similar to the leaves only more reduced; inflo-

rescences cymose with few to many tomentose or glabrous dichotomous or trichotomous branches, (1) 2.5-20 cm long; involucres sessile, turbinate, 1.5-3.5 mm long, 1-2 mm wide, tomentose to glabrous externally, glabrous internally, the 5 acute lobes from 1/6 to 1/3 the length of the tubes, the bractlets narrowly oblanceolate, 1-3.5 mm long, hirsutulous with long acute marginal cells, often with scattered capitate cells among the longer acute cells, the pedicels glabrous, 1.5-4 mm long; perianth white with greenish or reddish midribs, whitish-brown, pale yellow, or yellow, 2-3.5 (4) mm long, the calyx-segments ± similar, the outer whorl of segments oblanceolate to spathulate with acute or rounded apices, the inner segments elliptical, slightly shorter and narrower than the outer segments, glabrous except for a few scattered hyaline hairs or minute glands on the midribs within; stamens mostly included, 1-4 (5) mm long, the filaments glabrous or more commonly pilose basally, the anthers 0.3-0.5 mm long, oblong; achenes brown, 2-2.5 (3) mm long, the ovoid to subglabrous bases tapering to retrorsely roughened or roughened 3-angled beaks.

Key to the Varieties of Eriogonum corymbosum

A. Perianth white or brownish-white.

B. Leaves oblanceolate to elliptic, 1-3 (4.5) cm long, 1-2 cm wide, the petioles 2-6 mm long.

C. Involucres 1.5-2.5 mm long, 1-1.5 mm wide; stems spreading into subglobose crowns, the branches whitish-tomentose; perianth white; plants found mostly below 6000 feet, northwestern Colorado and adjacent southern Wyoming southward through northeastern and central Utah to north-central Arizona. 7a. var. *corymbosum*

CC. Involucres 2.5-3.5 mm long, 1.5-2 mm wide.

D. Stems and crowns open and erect, the branches brownish-tomentose; leaves 2-3.5 cm long, 0.5-1.5 cm wide, brownish-tomentose; plants found mostly above 6000 feet, northeastern Utah from western Wasatch Co. to extreme western Uintah Co. 7b. var. *erectum*

DD. Stems and crowns spreading, the branches silvery-tomentose; leaves 3-4 cm long, (0.5) 1-2 cm wide, silvery-tomentose; known only from Wellington, Carbon Co., Utah. 7c. var. *davidsei*

BB. Leaves elliptical-oblong to ovate-orbicular, 1-3 (4) cm long, 1-3 (3.5) cm wide, the petioles 5-10 (15) mm long.

C. Plants greenish; leaves densely tomentose below, subglabrous to glabrous and green above; perianth 2.5-3 mm long; plants found mainly on sandy soil, southeastern Utah and adjacent Colorado south into northeastern Arizona and extreme northwestern New Mexico. 7e. var. *orbiculatum*

CC. Plants brownish-white; leaves densely white-tomentose below, floccose and brownish- or yellowish-white above; perianth 2-2.5 mm long; plants found mainly on clay soils, west-central New Mexico. 7f. var. *velutinum*

AA. Perianth yellowish.

B. Perianth pale yellow to yellow, 2.5-3 mm long; involucres 2.5-3 mm long; inflorescences less than 2 cm long; extreme eastern Utah Co. and adjacent Duchesne Co., Utah 7d. var. *albogilvum*

BB. Perianth yellow, 1.5-2.5 mm long; involucres 1-2 mm long; inflorescences 3-10 cm long; southern Utah and northern Arizona. 7g. var. *glutinosum*

7a. *Eriogonum corymbosum* var. *corymbosum*

E. corymbosum var. *divaricatum* Torr. & Gray, Pacif. Railroad Report 2: 29. 1857. *E. divergens* Small, Bull. Torrey Bot. Club 33: 55. 1906, non *E. divaricatum* Hook. *E. effusum* Nutt. ssp. *divaricatum* S. Stokes, Gen. Eriog. 80. 1936. (TYPE: Near Green River, Emery Co., Utah, 1 Oct 1853, *Creuzfeldt on the Gunnison Expedition.* Holotype: NY! Isotype: GH!)

E. salinum A. Nels., Bull. Torrey Bot. Club 31: 240. 1904. *E. effusum* Nutt. ssp. *salinum* S. Stokes, Gen. Eriog. 81. 1936. (TYPE: Salt Well, Sweetwater Co., Wyoming, 17 Jul 1897, *A. Nelson 3753.* Holotype: RM! Isotypes: GH, US!

E. effusum Nutt. ssp. *corymbosum* S. Stokes, Gen. Eriog. 79. 1936.

E. effusum Nutt. ssp. *durum* S. Stokes, Gen. Eriog. 80. 1936. (TYPE: Sunnyside, Carbon Co., Utah, 13 Sep 1901, *M. E. Jones 11134.* Holotype: POM! Isotype: NY!)

Shrubs or subshrubs, 3-8 dm high, the crowns suberect to subglobose, up to 1 m across; leaves lanceolate to oblanceolate or elliptic, 1-3 (4.5) cm long, (0.3) 0.5-1 (1.5) cm wide, the petioles short, 2-6 (8) mm long; bracts scalelike above, often becoming foliaceous below; inflorescences mostly cymose, trichtomous nearly throughout, 3-10 cm long, usually densely tomentose but becoming subglabrous

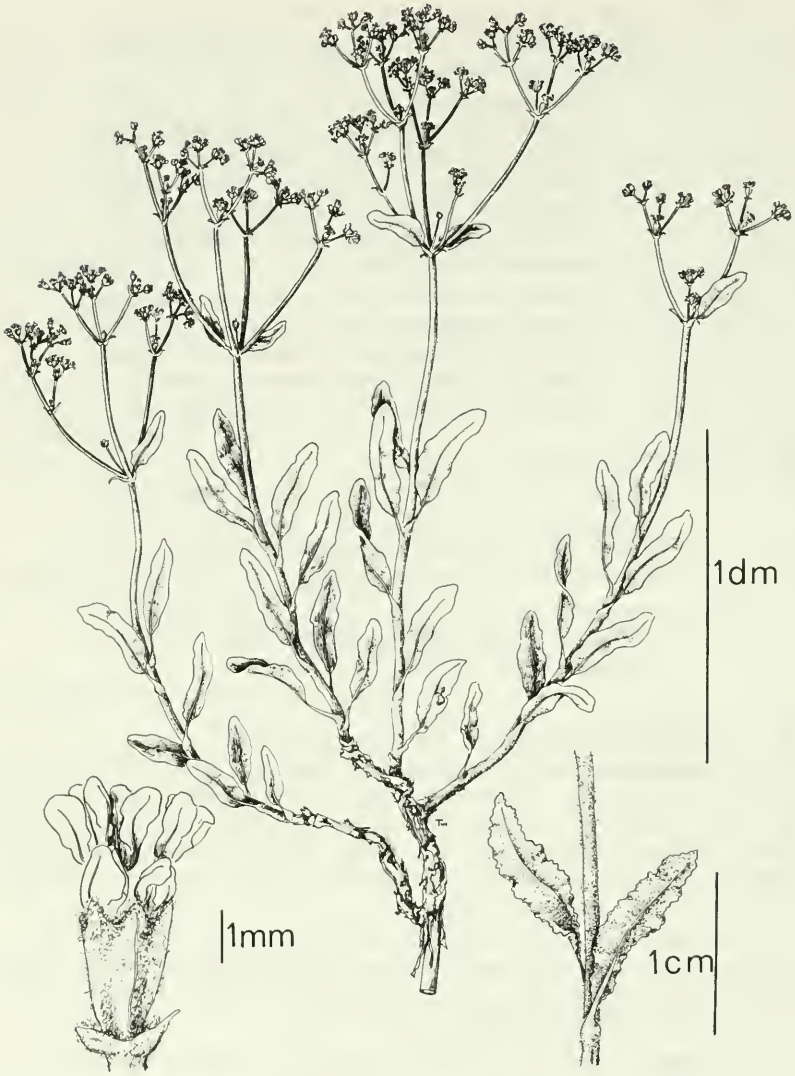


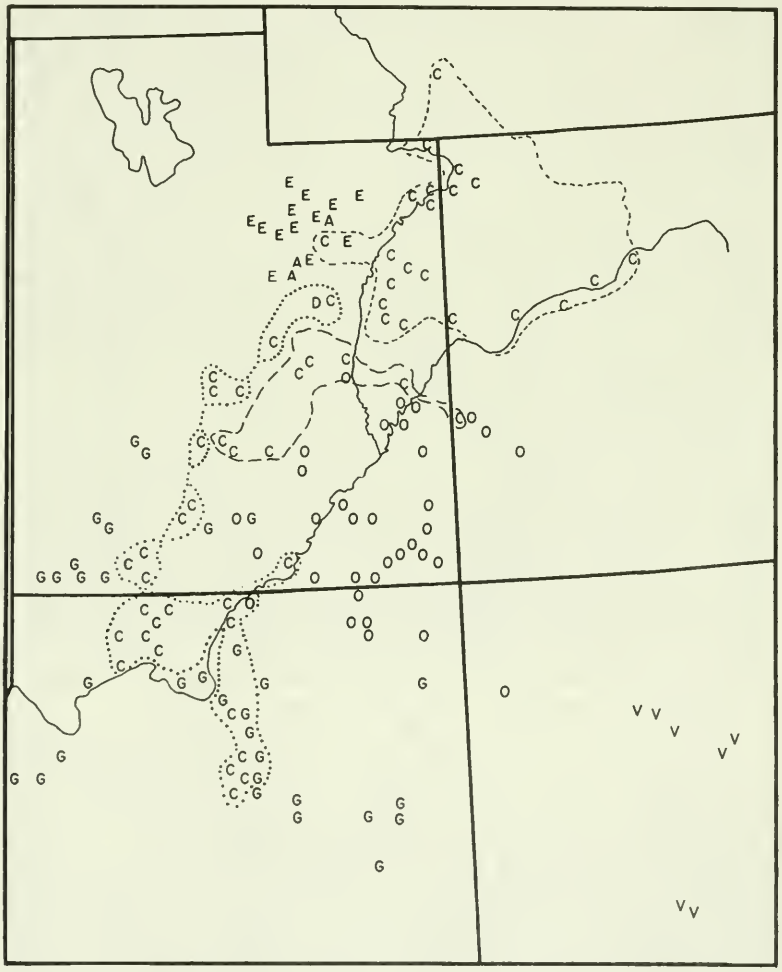
Fig. 7. Habit sketch of *Eriogonum corymbosum* var. *corymbosum* showing the general aspect of the species with enlarged drawings of the stem leaves and a single involucre with several exserted flowers.

in some; involucres 1.5-2.5 mm long, 1-1.5 mm wide; perianth white, 2-3 (3.5) mm long. Figure 7.

TYPE. COLORADO: Eagle Co. "On road—Day we reached Grand River." From the Frémont Report, the type area would be near Yarmony, NE of Piney Cr., near the Colorado River, 4 Sep 1845,

John C. Frémont 248. Holotype deposited at NY! Drawing, fragments, and photographs of this specimen are deposited at BRY. Isotype: GH!

DISTRIBUTION. Northwestern Colorado and adjacent southwestern Wyoming south through northeastern and central Utah to north-central and northwestern Arizona. Map 3. Flowering mainly from late July to early October.



Map. 3. Distribution in Utah, Colorado, Arizona, and New Mexico of *Eriogonum corymbosum*, var. *corymbosum* (C) with short dash lines showing the form of the variety represented by the type, the long dash lines showing the desert form, and the dotted line which represents the low mountain and southern form; var. *erectum* (E); var. *davidsei* (D); var. *albogilvum* (A); var. *orbiculatum* (O); var. *velutinum* (V); and var. *glutinosum* (G).

Representative Specimens. ARIZONA: Coconino Co., Navajo Bridge, *Darrow 2906* (ARIZ); Jumpup Spr., *Darrow 2972* (ARIZ, CAS); 13 mi SE of Fredonia, *Eastwood & Howell 6385* (CAS, US); 14 mi W of Cameron, *Kearney & Peebles 12826* (GH, US), *12827* (ARIZ); 2 mi SE of Fredonia, *Reveal 698* (ARIZ, BRY, CAS, DS, GH, KANS, MO, NY, OKL, RM, RSA, TEX, UC, US, UT, UTC, WIS); Moquitch Canyon, *Swapp 44* (USFS); Wapatki N. M., *Whiting 1089/5279* (ARIZ); Ryan, *Thackery 569* (ARIZ, US). Mohave Co., Between Fredonia and Mt. Trumbull, *Mann 2* (USFS); Boysag Point, *Michaels 23* (ARIZ). COLORADO: Garfield Co., 20 mi SW of Rifle, *Waterfall 11040* (OKL). Mesa Co., DeBeque, *Osterhout 4753* (NY, RM), *5848* (OKL, RM); 0.2 mi E of the Utah-Colorado line along U. S. Hwy. 50-6, *Reveal & Davidse 948* (BRY, NY, UTC). Moffat Co., Lodore Canyon, *Baker & Cutler 3489* (OKL); Dinosaur N. M., *Barmore s.n.* (UTC); Blue Mt., *McLeod 51A* (COLO). Montrose Co., Bedrock, *Payson & Payson 3924* (GH, RM). UTAH: Without definite location. Southern Utah, *Siler 141* (GH, ISC, MO, PH). Daggett Co., Hideout Camp, *Flowers et al. 216* (UT). Duchesne Co., 2 mi S of Duchesne, *Reveal 676* (BRY, NY, UTC). Emery Co., 0.5 mi N of San Rafael Bridge, *Harrison 9807* (BRY, UC, UTC); San Rafael Swell, *M. E. Jones s.n.* (POM); 6 mi SE of Castle Dale, *McVaugh 14593* (CAS, MICH, NY); Cottonwood Canyon, *Ware 179* (USFS). Garfield Co., Bryce Canyon N. P., *Eastwood & Howell 7170* (CAS, GH, UC, UTC); 15 mi N of Widtsoe, *Holmgren et al. 2253* (BRY, CAS, DS, GH, ISC, MO, NY, OSC, RSA, TEX, UC, UTC). Grand Co., Turnbow Cabin, Arches N. M., *Welsh & Moore 2709* (BRY). Kane Co., E of Zion N. P., *Eastwood & Howell 6374* (CAS); Mt. Carmel, *Eastwood & Howell 7127* (CAS); Mt. Carmel Junct., *Harrison 11067* (BRY, UC, US, UTC); Glendale, *M. E. Jones 6047b* (MO, NY, UC); 2 mi above the Lake Canyon, *Lindsay 103* (WIS); N of Kanab, *Milner 8959* (US); ¼ mi S of Glendale, *Reveal & Holmgren 316* (UTC, WTU). Sevier Co., Tony's Hollow, *Martineau 119* (USFS); 1 mi up Red Cr., Salina Canyon, *Stevens 90* (BRY, UTC). Uintah Co., Dinosaur N. M. Headquarters, *Bradley 5371* (COLO); 33 mi S of Ouray, *Brotherson 453* (BRY); 12 mi S of Ouray, *Brotherson 519, 520* (BRY); Split Mt. Gorge, *Brotherson 776* (BRY); Quarry, Dinosaur N. M., *Brotherson 830* (BRY); 23 mi SE of Ouray, *Holmgren et al. 2267* (BRY, CAS, DS, MO, NY, OSC, RM, TEX, UC, US, UT, UTC); 32 mi SE of Ouray, *Holmgren et al. 2269* (BRY, CAS, DS, GH, MO, NY, OSC, RM, TEX, UC, US, UT, UTC); Tabyago Canyon, *Holmgren et al. 2350* (BRY, CAS, DS, GH, MO, NY, RM, RSA, TEX, UC, US, UT, UTC, WIS); Upper Hill Cr., Tavaputs Plateau, *Vickery & Wiens 1662* (DS, RSA, UC, UT, WTU); Overlook, Split Mt. Gorge, *Welsh 379* (BRY). Wayne Co., Fruita, *Beck s.n.* (BRY); 7 mi E of Teasdale, *Harrison et al. 7536* (BRY); Grover, *Holmgren, et al. 2547* (BRY, NY, UTC); 5 mi E of Teasdale, *Holmgren et al. 2550* (BRY, NY, UTC); Wayne Wonderland, *Milner 7242* (UT); Rabbit Valley, *Ward 561* (US).

The critical part of the discussion of *E. corymbosum* var. *corymbosum* is in regards to the type collection (fig. 8). First, the Frémont collection was made in 1845, and the label data given indicates that he obtained the specimens from near Yarmony, Eagle Co., Colorado. No other collection of this species is known at present to come from this area, and a recent visit to this area failed to reveal the plant. Thus, if the type came from this area, it is the easternmost collection. The interested reader of far western history of the United States will recall that following this collection, Frémont made an extended exploration trip through Utah, Nevada, and California, became involved in the Bear Flag Revolt and for his part in this affair was ordered out of the state into Oregon only to return later and become involved in the fight for California's independence from Mexico in the Mexican War. Needless to say, the type specimen of *E. corymbosum* went with him throughout his adventure, and suffered considerably. The specimens became partially destroyed, broken in places, and heavily infected with matted mycelium of a fungus. With such poorly preserved material, it was necessary for me to carry out de-

Fig. 8. Photograph of the holotype of *Eriogonum corymbosum*.

tailed morphological studies in order to correctly associate the subsequent specimens.

The holotype is deposited at the New York Botanical Garden and has few leaves, although the isotype at the Gray Herbarium has a few more. Thus, except for the leaf studies, all of the details have been taken from the holotype. The inflorescence of the holotype was manufactured when the specimen was mounted. The small pieces which bear the involucres were glued down to give a corymbose appearance rather than a cymose inflorescence as seen in the isotype, and in most of the subsequent collections. The pubescence of the stems, leaves, and involucres is obscured by the fungal mycelium. However, in a few small places, it is possible to see the kind of pubescence, and it too compares favorably with modern specimens.

When Torrey worked on the collection, he made a series of drawings on a small sheet of blue paper. Although the pencil drawings have faded over the years, they are still visible, and compare favorably with the present observations. Fortunately, the concept of *E. corymbosum* as held by most taxonomists is represented by the type, and through all of the difficulties experienced with the type collection, it has been possible to ascertain the identity of the holotype and conclude that the type represents that part of the overall species as outlined in this paper.

This conclusion was aided by several additional key specimens. The specimen at hand that comes closest to the holotype is another type collection. Aven Nelson collected the only specimens of *E. corymbosum* known from Wyoming[2] and described it as *E. salinum*. In making detailed comparisons with the Frémont collection, the Nelson specimens were found to be nearly identical. The several collections from the Dinosaur National Monument area also resemble the type closely, but these tend to have bracts which are somewhat longer and with the stem leaves closer together on the stem.

The plants from northwestern Colorado and adjacent northeastern Utah are generally of a shorter stature than those plants found elsewhere. The larger plants to the south which are generally in the foothills and the mountains were recognized by Stokes under the name *E. effusum* Nutt. ssp. *durum*, while the plants of intermediate stature which generally occur in the desert were described earlier as *E. corymbosum* var. *divaricatum* by Torrey and Gray.

In *E. corymbosum* var. *corymbosum* several different populations may be seen which are associated with corresponding variation in ecology and geology. As noted above, those plants which are similar to the holotype range from northwestern Colorado and adjacent Wyoming, westward into northeastern Utah, then south onto the Tavaputs Plateau (Map 3, p. 309). This southern line ends where this high plateau breaks off into the Roan and Book cliffs.

At the base of the Book Cliffs is the larger and more robust plant which Stokes named ssp. *durum*. The *durum* phase of var. *corymbosum* extends westward from the Book Cliffs over to the eastern front of the Wasatch Plateau, then southward along the mountains to its southern end where the species crosses the mountains and continues southward into southwestern Utah and adjacent Arizona (Map 3).

The desert form of *corymbosum* extends down the Green River drainage, and southward from the Book Cliffs onto the San Rafael Desert and the San Rafael Swells, with outlying populations in Arches National Monument and adjacent areas, and in extreme western Colorado. This plant was described as var. *divaricatum*. The *divaricatum* form of the variety is found on the clay soils, and

2. Recently (3 Aug 1967) Dr. C. L. Porter of the University of Wyoming recollected this variety in Wyoming in the same location as Nelson, 35 miles south of Rock Springs, *Porter & Porter 10508* (BRY, RM). He found, intermixed with this species and *E. brevicaule* (*10509*), a series of hybrids that would key out to the var. *albogilvum* (*10510*). However, unlike the Utah plants of var. *albogilvum*, the Wyoming plants seem to be only first generation hybrids.

extends as far south as this kind of soil is found or to where the sandy desert and *E. corymbosum* var. *orbiculatum* are encountered (Map 3).

Even though it is possible to discuss these various populations which have been given names, their distinction in the herbarium and in the field is not as great nor as consistent for recognition with as much certainty as those given formal taxonomic rank in this paper. In coming to this conclusion, no consistent separation was found possible when the geographical location was disregarded. Additional critical and detailed study may show that some of these forms can be distinguished, but if they are, other populations which are equally as distinct, will have to be recognized. At present, plants from Arches National Monument and the Capital Reef area are different, as are the plants in the foothills north of Bryce Canyon. Thus, as I see it, the var. *corymbosum* is a large and still variable taxon that is undergoing still more geographical isolation and speciation.

In southwestern Utah and particularly in northern Arizona, the var. *corymbosum* is similar to var. *glutinosum* in several features, and at times the two seem to differ only in flower color. Both occur in similar habitats, and often may be found growing in mixed populations. Considerable work (and probably genetic studies) is needed on this part of the species. As far as this paper is concerned, the two varieties will be basically separated on flower color, but realizing that in some populations, especially some of those in Arizona, the distinction may be artificial.

The relationships of *E. corymbosum* to the other species discussed in this paper show a reticulated pattern of development, and the linear arrangement of the species is therefore somewhat misleading. Probably the entity that comes closest to *E. corymbosum* is *E. hylophilum*; however, as noted in the discussions of the various species, this relationship is not clearly understood and highly speculative (fig. 9).

During recent field studies in western Colorado (1967), *E. sarothriforme* Gandg. (*Bull. Soc. Bot. Belg.* 42: 192. 1906) was seen and studied. Stokes (1936) reported that this species was referrable to *E. corymbosum*, but in my opinion, *E. sarothriforme* is a member of the *E. brevicaule* complex. The Colorado species has long, narrow, green basal leaves at the base of a green and glabrous branching inflorescence. It occurs mainly in Garfield Co., with a single floccose-tomentose collection (*Reveal & Davidse 860*) coming from Eagle Co.

The following varieties of *E. corymbosum* are all based on gross morphology, and the relationships expressed between them are mainly speculations.

7b. *Eriogonum corymbosum* var. *erectum* Reveal & Brotherson, var. nov.

A var. *corymboso* plantis fruticosis ad 6-10 dm altis, ubique brunneo-tomentosis, foliis lanceolatis vel ellipticis, 2-3.5 cm longis,

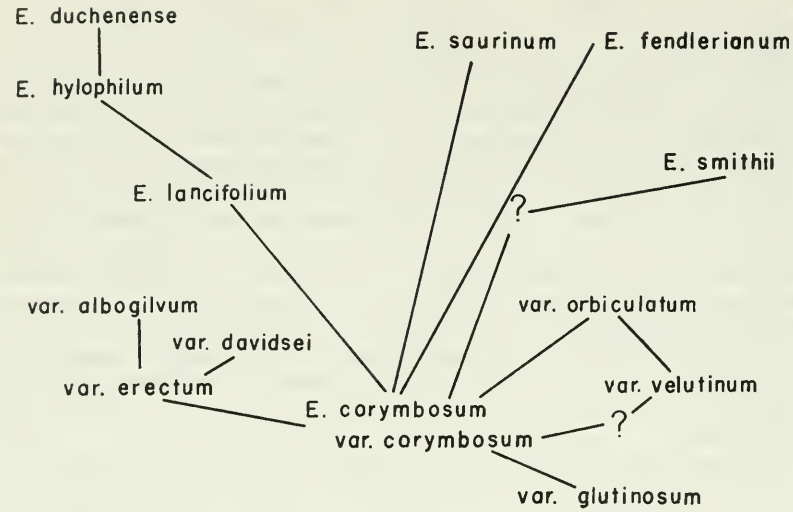


Fig. 9. Diagram showing the possible relationships between the various species and varieties in the *Eriogonum corymbosum* complex.

0.5-1.5 cm latis, inflorescentiis brevibus et compactis, densis, 2.5-7 cm longis, erectis, involucris 2.5-3.5 mm longis, 1.5-2 mm latis, perianthiis albo-brunneis, costa basi rosea, 2.5-3 mm longis differ.

Erect shrubs (3) 6-10 dm high, brownish-tomentose nearly throughout; leaves lanceolate to elliptic, 2-3.5 cm long, 0.5-1.5 cm wide, densely tomentose below, less so to subglabrous and green above, appressed to the stems and erect, the leaf-blades thick and stiff; inflorescences mostly short and compact, the branches dense, 2.5-7 cm long; involucres 2.5-3.5 mm long, 1.5-2 mm wide; perianth brownish-white with reddish midribs and bases, 2.5-3 mm long. Figure 10.

TYPE. UTAH: Wasatch Co. Along U. S. Hwy. 40, 5.5 mi E of Strawberry Reservoir, 33 mi W of Duchesne, sec. 28, T. 7 S., R. 10 W., elevation 7500 feet, 16 Aug 1966, *Noel H. Holmgren & James L. Reveal 3022*. Holotype deposited at UTC. Isotypes distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

DISTRIBUTION. Widely scattered in northeastern Utah from Wasatch Co. to extreme western Uintah Co., Utah, mainly above 6000 feet elevation. Map 3. Flowering mainly from August to September.

REPRESENTATIVE SPECIMEN. UTAH: Duchesne Co., 10 mi up the Tabiona Road, *Atwood 675* (BRY, UTC); 10 mi N of Altonah, *Brotherson 604* (BRY); 5 mi N of Fruitland, *Brotherson 477, 478* (BRY); 15 mi SW of Myton, *Brotherson 720, 735* (BRY); Rock Cr., *Brotherson 900* (BRY); Hanna, *Christensen s.n.* (BRY); 0.6 mi up Grass Hollow, Indian Creek Canyon, *Holmgren & Reveal 3021* (BRY, NY, UTC); Pine Hollow, *Hutchings s.n.* (ARIZ); 16 mi N of Duchesne, *Maguire 12523* (GH); 1 mi W of Mountain Home, *Stoddart & Passey s.n.* (OKL, UTC); 7 mi N of Duchesne, *Stoddart & Passey s.n.* (OKL, UTC). Summit Co., Uinta Mts., *Milner 6766b* (UT). Uintah Co., Dry Fork Mt., *Andrews & Noble s.n.* (DS, WS); 5 mi

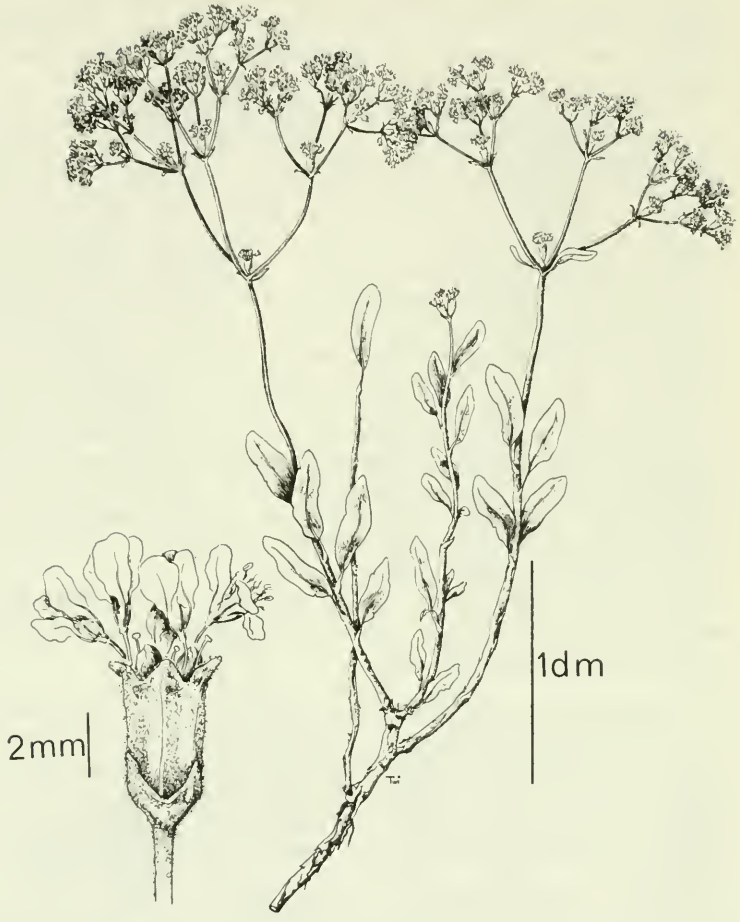


Fig. 10. Habit sketch of *Eriogonum corymbosum* var. *erectum* showing the erect stems and stem leaves with an enlarged drawing of a single involucre with several exserted flowers.

NW of Whiterock, *Brotherson 551* (BRY); near Roosevelt, *Thorne 18926* (RSA). Utah Co., 12 mi E of Soldier Summit, *Reveal & Reveal 724* (BRY, NY, UTC); 12 mi E of Soldier Summit, *Welsh & Moore 3426* (BRY). Wasatch Co., Strawberry Res., *Brotherson 669* (BRY); Wolf Cr., *Garrett 7487* (CAS, DS); between the head of Daniel's Canyon and Duchesne, *Garrett 8037* (MO, UC, UT); 5 mi E of Strawberry Res., *Maguire 17652* (GH, IDS, NY, OKL, UC, UTC), *17653* (NY, OKL, UC, UTC, WTU); 2 mi N of the summit of Indian Creek Canyon, *Maguire 21324* (GH, UTC).

The discovery of this variety came as a result of detailed ecological studies by Jack D. Brotherson, presently a graduate student at Iowa State University, Ames, Iowa. Brotherson's master's thesis (1967), on the ecology of *E. corymbosum* in the Uinta Basin, dis-

closed that two distinct forms existed in this area. From herbarium studies, Brotherson and I could easily note var. *corymbosum* and var. *erectum* on the basis of the latter's more erect stems and decidedly brownish tomentose stems and branches.

In the field, the two taxa are quite distinctive. The var. *erectum* has a distinct brownish cast to its tomentum that is readily seen, and the crowns possess few and more erect stems. The leaves of var. *erectum* are generally not as spreading as in the var. *corymbosum*. Lastly, as Brotherson (1967) has shown, var. *erectum* occurs in scattered patches where it is often associated with *Artemisia* in Pinyon-Juniper Woodlands. This is unlike var. *corymbosum* of the lower portion of the Uinta Basin which is normally restricted to the clay hills and slopes where it is often associated with *Atriplex*. The distinct elevational differences between the two varieties are probably best seen in Indian Creek Canyon, southwest of Duchesne. The upper elevations have scattered plants of var. *erectum;* however, as one proceeds down the canyon, var. *erectum* is reduced in numbers and at middle elevations it is missing altogether. At the lower end of the canyon, long, rolling hills of a clay formation are found, and on these hills, var. *corymbosum* is fairly common. There is a gap of some five to eight miles between the two varieties, as well as nearly a thousand feet in elevation.

The relationship of var. *erectum* to var. *corymbosum* seems to be rather clear, with the var. *erectum* occupying a different ecological niche and geographical range.

7c. *Eriogonum corymbosum* var. *davidsei* Reveal, var. nov.

A var. *corymboso* et var. *erecto* plantis fruticosis 8-12 dm altis, ubique argenteo-tomentosis, foliis lanceolatis vel ellipticis, 3-4 cm longis, (0.5) 1-2 cm latis, inflorescentiis brevibus et compactis, densis, 3-6 cm longis, patulis, involucris 2.5-3 mm longis, 1.5-2 mm latis, perianthiis albo-brunnis, costa basi olivacea, 2-2.5 mm longis differt.

Large spreading shrubs 8-12 dm high and 5-15 (20) dm across, silvery-tomentose nearly throughout; leaves lanceolate to elliptic, 3-4 cm long, (0.5) 1-2 cm wide, densely tomentose below, less so but tomentose and whitish-green above, spreading from the stems, the leaf-blades thin and lax; inflorescences mostly short and compact, the branches dense, 3-6 cm long; involucres 2.5-3 mm long, 1.5-2 mm wide; perianth brownish-white with olive-green bases and thin, nearly indistinct, midribs, 2-2.5 mm long. Figure 11.

TYPE. UTAH: Carbon Co. 0.7 mi S of U. S. Hwy. 50-6 at Wellington just south of the Price River Bridge on the dirt road to Mound, on steep dark Mancos Shale hills, 9 Sep 1967, *James L. Reveal & Gerrit Davidse 956.* Holotype deposited at UTC. Isotypes distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

DISTRIBUTION. Known only from the low Mancos Shale hills on the river bank along the Price River south of Wellington, Carbon Co., Utah. Map 3. Flowering from August to October.

Fig. 11. Habit sketch of *Eriogonum corymbosum* var. *davidsei* showing the general aspect of the species with an enlarged drawing of a single involucre with several exserted flowers.

Specimens Examined. Known only from the type although additional living material was obtained on 12 Oct. 1967 for illustrations and further study.

The var. *davidsei* seems to be closely related to var. *erectum* from which it differs only in a few technical characteristics. Nevertheless, var. *davidsei* is distinct in its ecological and edaphic requirements. As noted above, the var. *erectum* commonly occurs in the mountains on sandy soils associated with *Artemisia* in pinyon-juniper. The var. *davidsei*, on the other hand, is found on low rolling Mancos Shale hills south of Wellington, Utah, where it is associated with *Atriplex*. The type area of the new variety is along the banks of the Price River and the plants are exceedingly large and robust, most unlike the narrowly erect, few branched forms of var. *erectum*. The leaf width and length of var. *davidsei* is the greatest in this part of *E. corymbosum*, but it does not approach the leaf length-width ratio of either var. *orbiculatum* or var. *velutinum*.

The most striking morphological feature observed in the field is the silvery tomentum which is exceedingly soft and felt-like. This gives the plants a distinct cast against the otherwise dark clay slopes and allows them to be easily seen from a distance. The crowns which tend to be densely branched with numerous short flowering inflorescences also give the plants a distinct appearance as the resulting round-shaped crowns are a mass of flowers, although the crowns are not as dense as in var. *orbiculatum*. When this plant was collected in September, it was necessary to scare away numerous honeybees which were probably from local hives in the Wellington area. Some small flies were also seen on the flowers.

This variety is named for Mr. Gerrit Davidse, a graduate student in botany from Utah State University, Logan, who collected with me on an extended trip into Texas and adjacent states in August and September, 1967.

7d. *Eriogonum corymbosum* var. *albogilvum* Reveal, var. nov.

A var. *erecto* plantis subfruticosis, (1.5) 2-4 dm altis, foliis ellipticis, 1-2 (2.5) cm longis, 4-7 mm latis, supra virido-tomentosis, subra subglabris et viridis, inflorescentiis brevibus et compactis, 1-3 cm longis, involucris 2.5-3 mm longis, 1.5-2 mm latis, perianthiis albo-gilvum vel gilvum differt.

Erect subshrubs, (1.5) 2-4 dm high, whitish to brownish tomentose nearly throughout; leaves elliptical, the leaf-blades 1-2 (2.5) cm long, 4-7 mm wide, densely greenish-white tomentose below, subglabrous and green above, appressed to the stems and erect, the petioles 1-3 mm long; inflorescences short and compact, 1-3 cm long; involucres 2.5-3 mm long, 1.5-2 mm wide; perianth pale yellow to yellow with reddish-brown midribs and bases, 2.5-3 mm long. Figure 12.

Type. utah: Duchesne Co. About 3 mi N of the Indian Creek Canyon Summit along Utah Hwy. 33, on steep hillside, sec. 1, T. 10 S., R. 8 W., elevation 8500 feet, 26 Aug 1966, *James L. Reveal & Caroline G. Reveal 726*. Holotype deposited at utc. Isotypes will

Fig. 12. Habit sketch of *Eriogonum corymbosum* var. *albogilvum* showing the erect stems and short compact inflorescences with two enlarged sketches of the basal node of the inflorescence which shows three involucres and several exserted flowers subtended by bracts, and a single enlarged involucre with several exserted flowers.

be distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

DISTRIBUTION. Infrequent and widely scattered in the upper end of Indian Creek Canyon, east of Soldier Summit at the head of Price Canyon, and north of Duchesne, in Duchesne and Utah counties, Utah. Map 3. Flowering mainly in August and September.

Specimens Examined. utah: Duchesne Co., 8 mi N of Duchesne along Utah Hwy. 87, *Welsh & Moore 6775* (bry). Utah Co., 12 mi E of Soldier Summit, *Reveal & Reveal 725* (bry, ny, utc); 12 mi E of Soldier Summit, *Welsh & Moore 3425* (bry).

It is suggested that *E. corymbosum* var. *albogilvum* is of a hybrid origin between *E. corymbosum* var. *erectum* and *E. brevicaule* Nutt. var. *laxifolium* (Torr. & Gray) Reveal[3] or var. *pumilum* S. Stokes ex M. E. Jones. Evidence for this statement is based on field observations and on pollen analysis. In the field, var. *albogilvum* is always associated with the two suggested parents, and is intermediate in several respects to them. The var. *albogilvum* is similar to var. *erectum* in its overall morphology, and is not at all similar to *E. brevicaule* var. *laxifolium* which is low and nearly caespitose with its tomentose stems less than 10 cm long and topped by a capitate inflorescence. Nor is the var. *albogilvum* similar to var. *pumilum* which has an umbellate inflorescence and otherwise similar to var. *laxifolium*. The flowers of var. *erectum* are brownish-white, while those of var. *laxifolium* and var. *pumilum* are yellow. The flowers of var. *albogilvum* are mostly pale yellow, although the plants from north of Duchesne (*Welsh & Moore 6775*) vary from pale yellow to bright yellow, and thus of an intermediate condition. The stem and branch pubescence is similar to var. *erectum*, but the leaf pubescence which is greenish and nearly glabrous above, is similar to var. *laxifolium* and var. *pumilum*. The leaf shape, however, is similar to var. *erectum* and not at all similar to the leaves found in the two varieties of *E. brevicaule*.

From the pollen analysis of the type collection, it has been found that the var. *albogilvum* has from 80 to 90 percent of its pollen viable, and this seems to show some hybridization has occurred but that its effect has been lessened, possibly by backcrossing. Both of the supposed parents were found to have about 100 percent pollen fertility.

In Indian Creek Canyon and north of Duchesne where the populations are rather extensive, the var. *albogilvum* appears to have become stabilized, and apparently is not backcrossing with var. *erectum*. However, at the site east of Soldier Summit, the var. *albogilvum* appears to be in danger of becoming swamped by var. *erectum*, and this population is not nearly as stable as the other known populations.

3. The large and complex species, *Eriogonum brevicaule*, is in a current state of reevaluation, especially in Utah where several distinct forms are found. Although considerable adjustment must be made in the rest of the species in Utah, this combination is made so that it can be used in this paper and in the *Eriogonum* treatment for the Pacific Northwest Flora. The var. *laxifolium* ranges from 5000 feet to more than 10,500 feet elevation, and may be distinguished from the other varieties in *E. brevicaule* by its capitate inflorescences. Along the middle elevations of the Wasatch Front, the var. *laxifolium* is largely replaced by the var. *pumilum* S. Stokes ex M. E. Jones. The combination may be made as follows:

The following are synonyms:

Eriogonum brevicaule Nutt. var. *Laxifolium* (Torr. & Gray) Reveal, comb. nov.

E. kingii Torr. & Gray var. *laxifolium* Torr. & Gray, Proc. Amer. Acad. 8:165. 1870. *E. chrysocephalum* A. Gray, Proc. Amer. Acad. 11:101. 1876, a substitute name for var. *laxifolium*. *E. ochrocephalum* S. Wats. var. *angustum* M. E. Jones, Contr. West. Bot. 11:9. 1903. *E. medium* Rydb., Flora Rocky Mts. 220. 1917. *E. nudicaule* (Torr.) Small ssp. *angustum* S. Stokes, Gen. Eriog. 84. 1936. *E. chrysocephalum* A. Gray ssp. *bannockense* S. Stokes, Leafl. West. Bot. 3:200. 1941. *E. bannockense* attrib. to S. Stokes by R. J. Davis, Flora Idaho 246. 1952.

The var. *albogilvum* presents several difficult problems in regards to nomenclature. The fact that hybrids exist is no longer questioned, and even now the International Code (1966) provides for their nomenclatural recognition. The problem with var. *albogilvum* is that it is of a hybrid origin between two different species, and backcrossed onto one of the parents, and while in this immediate point of time it seems to be stable, it may not continue to exist as a descrete and self-reproducing population.

Several approaches to this problem can be taken. First, the plants can simply be ignored, or mentioned in the discussion as an occasionally found population. Secondly, the plants can be given a species hybrid name, but as I understand the Code, this is usually restricted to sterile F_1 hybrids, and I think such a concept should continue. This population may be recognized, taxonomically, as a mere form, but again, for those who prefer the use of *forma*, of which I am not one, these are usually single individuals which differ from the rest of the population in some (often mutable) single characteristic. Actually, the var. *albogilvum* does not really fit into any of these categories. Variation within species are often introduced from outside species through hybridization. Yet there is no reason to assume that the same thing cannot happen within a definable part of the species, or as in our case, within a variety of the species. Normally such occurrences are unsuccessful, or happened so long ago that the incoming characteristics have been incorporated within the population and only by experimental evidence is it possible to discover this outside influence.

7e. *Eriogonum corymbosum* var. *orbiculatum* (S. Stokes) Reveal & Brotherson, stat. & comb. nov.

E. effusum Nutt. ssp. *orbiculatum* S. Stokes, Gen. Eriog. 79. 1936.

E. divergens sensu authors, non *E. corymbosum* var. *divaricatum* Torr. & Gray.

E. jonesii sensu authors, non *E. jonesii* S. Wats.

E. nummulare sensu authors, non *E. nummulare* M. E. Jones.

Large subshrubs or shrubs, 3-12 dm high, forming compact, hemispherical crowns of numerous divaricated branches, the shrubs often bright green; leaves elliptical-oblong to ovate-orbicular, 1-3 (4) cm long, 1-3 (3.5) cm wide, floccose to tomentose on both surfaces, often somewhat less dense above than below, the petioles 5-10 (15) mm long; inflorescences of dense, compact, short branches, often up to 20 cm long, rigid; perianth white with green or reddish midribs and bases, 2.5-3 mm long. Figure 13.

TYPE. UTAH: Emery Co. Green River, 3 Nov 1915, *M. E. Jones s.n.* Holotype deposited at POM! Isotypes: DS, POM!

DISTRIBUTION. Eastern Utah south of the Book and Roan cliffs and adjacent western Colorado south along the Green and Colorado

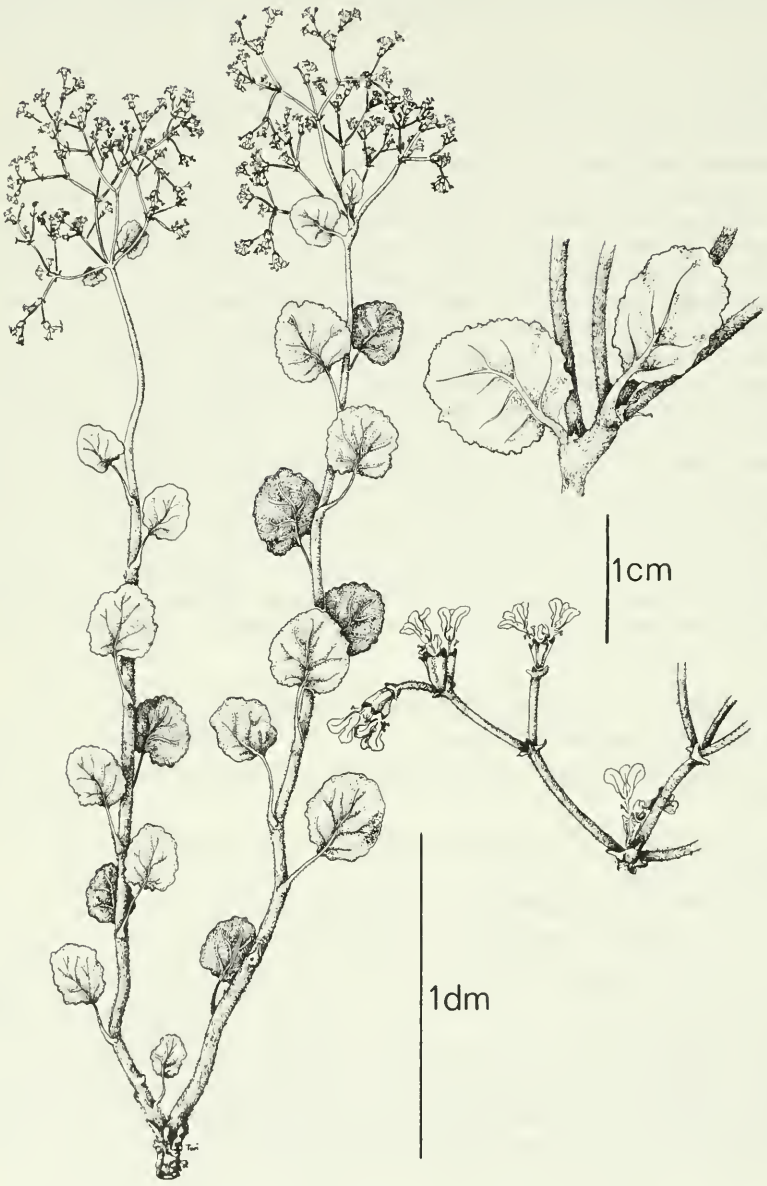


Fig. 13. Habit sketch *of Eriogonum corymbosum* var. *orbiculatum* showing the narrowly erect stems and compact inflorescences with enlarged drawings of part of an inflorescence with several involucres and exserted flowers and of the basal node of the inflorescence with large leaves at this node.

river drainages into northeastern Arizona and adjacent northwestern New Mexico. Map 3. Flowering from late July to early November.

REPRESENTATIVE SPECIMENS. ARIZONA: Apache Co., Between Many Farms and Round Rock, *Barr et al 1991a* (ARIZ, UT). Coconino Co., 2 mi below Navajo Bridge, *Cutler 3189* (GH, NY OKL); Bass Canyon, Grand Canyon, *Thornber 2821G* (ARIZ). Navajo Co., 3 mi N of the Totem Poles, *Blass 33* (UC); 8 mi E of Kayenta, *Cutler 2876* (DS, NY); Kayenta, *Eastwood & Howell 6547* (CAS, DS, GH, NY, POM, UC, US); 28 mi SE of Kayenta, *Hutchinson 7432* (COLO); Monument Valley, *Peebles & Fulton 11947* (ARIZ). COLORADO: Montrose Co., 1 mi above Uravan, *Ownbey 1506* (DS, GH, IDS, MO, MONTU, NY, ORE, RM, UC, USFS, UTC, WS, WTU); 31 mi SE of Gateway, *Weber 3564* (ARIZ, BM, CAS, COLO, DS, MONTU, OKL, PH, RM, RSA, TEX, UC, UTC, WS, WTU). San Miguel Co., Basin Cr., *Ownbey 1499* (CAS, DS, IDS, NY, OKL, POM, UC, US, UTC, WS, WTU). NEW MEXICO: Without definite location. Mesa la Vaca, *Marsh 244* (US); Bad Lands, *Wooton 2815* (ARIZ, US). McKinley Co., Chaco Canyon, *Clark s.n.* (NMU). UTAH: Garfield Co., 17 mi S of Escalante, *Beck s.n.* (BRY); 50 mi S of Escalante, *Beck s.n.* (UTC); Tickaboo Canyon, Colorado River, *Lindsay 21* (UC, WIS); Mt. Ellen, *Osgood s.n.* (US). Grand Co., Moab, *M. E. Jones in 1891* (MO, US), *in 1913* (POM); 6 mi N of Moab, *Maguire & Maguire 5852* (UTC); 6 mi W of Moab, *Maguire & Richards 13301* (GH, NY, OKL, UTC); near Castleton Cr., *Moran 1419* (DS); 8 mi NW of Moab, *Waterfall 11407* (OKL, UTC); Courthouse Towers, Arches N. M., *Reveal 686* (ARIZ, BRY, CAS, DS, GH, KANS, MO, NY, OKL, OSC, RM, RSA, TEX, UC, US, UT, UTC, WIS). San Juan Co., Bridge Canyon, Natural Bridges, N. M., *Clover 4039* (ARIZ); 8 mi NW of Oljeto Post, *Cutler 2251* (CAS, GH, MO, US); 1 mi NW of Wide Butte, *Cutler 2989* (DS, GH, NY, OKL), *2999* (DS, GH, NY, OKL, WIS); Cooper Canyon, *Cutler 3169* (DS, NY, OKL); Barton Range, *Eastwood 129* (GH, MO, UC, US); Cottonwood Wash, *Ferris 11638* (DS); Rainbow Bridge Trail, *Goodman & Payson 3261* (UC, WTU); 3 mi N of Red Mesa, *Harrison 12189* (BRY); Monument Valley, *Holmgren 3850* (GH, NY, UC, UTC, WIS, WS); Monument Pass, Monument Valley, *Holmgren & Reveal 2999* (BRY, NY, UTC); 8 mi S of Bluff, *Maguire et al. 5851* (GH, UC, UTC); 15 mi S of LaSal Junct., *Reveal 687* (ARIZ, BRY, CAS, DS, GH, KANS, MO, NY, OKL, OSC, RM, RSA, TEX, UC, US, UT, UTC, WIS); 1.2 mi E of Utah highway 47 on Utah highway 262, *Reveal 689* (ARIZ, BRY, CAS, DS, GH, KANS, MO, NY, OKL, OSC, RM, RSA, TEX, UC, US, UT, UTC, WIS); near The Tanks, *Rydberg & Garrett 9875* (GH, MO, NY, US, WIS); 3 mi S of Kane Spr., *Welsh & Moore 1846* (BRY, ISC, WIS); Elephant Hill, *Welsh et al. 3707* (BRY); 1 mi E of Upheaval Dome, *Welsh & Moore 3854* (BRY). Wayne Co., Marvine Laccolite, *M. E. Jones 5663* (MO, NY, POM, UC, US).

Eriogonum corymbosum var. *orbiculatum* has been known to taxonomists under a variety of names for several years. In 1906, Small proposed a new name for *E. corymbosum* var. *divaricatum*, but when he applied the name, *E. divergens*, to plant specimens, they represented the var. *orbiculatum* instead of the kind of plant typified by the Gunnison expedition type. Rydberg, in his flora on the Rocky Mountains (1917), applied the name *E. jonesii* S. Wats. to this population, and this error has resulted in the reports of this species being found in Utah. Actually, *E. jonesii* is a narrow endemic species known only from northwestern Arizona (Reveal, in press c). While *E. jonesii* does approach var. *orbiculatum* in its wide leaves, *E. jonesii* has leaves that are cordate and nearly always basal, and not at all like var. *orbiculatum*.

In her monograph, Stokes (1936) discusses at some length the variation in the taxon, and yet, for some reason, she selected as the type a Jones specimen that is on the very edge of the variation within what is here defined as var. *orbiculatum*. Certainly the leaves are rotund, but they are exceedingly small, and the plants in the type

area tend to be somewhat less hemispheric in shape than those found further to the south.

The hemispheric crowns in this variety are rather interesting to observe in the field. The new year's growth begins on the stems of the previous year and grows slowly throughout the spring and early summer. As the season moves into July, the branches divide into the inflorescences which are so profuse as to make the top of the crown exceedingly firm and rigid. In late August the crowns which are bright green start to flower. The green branches of the inflorescences are gradually masked by the white flowers so that in September massive rounded humps are seen spotting the red sands in southeastern Utah.

7f. *Eriogonum corymbosum* var. *velutinum* Reveal, var. nov.

A var. *orbiculato* plantis fruticosis ad 5-10 dm altis, ubique albotomentosis, foliis ellipticis vel oblongis, (1.5) 2-2.5 cm longis, (1) 1.5-2.5 cm latis, inflorescentiis compactis, densis, 4-9 cm longis, perianthiis brunneo-albis, 2-2.5 mm longis differt.

Large, densely grayish-white tomentose shrubs 5-10 dm high, the tomentum matted and velvet-like, the plants forming rather compact crowns of several branches; leaves elliptical to oblong, mostly truncate at the bases, (1.5) 2-2.5 cm long, (1) 1.5-2.5 cm wide, densely white-tomentose below, less so and brownish-floccose above, the petioles 0.5-1.5 cm long; inflorescences of dense, compact, short branches, 4-9 cm long, densely tomentose; perianth brownish-white with light brown midribs and bases, 2-2.5 mm long. Figure 14.

TYPE. NEW MEXICO: Socorro Co. 7.6 mi E of the junction of Interstate 25 and U. S. Hwy. 380 near San Antonio, at the base of a small ridge system in dark, heavy soil, 5 Sep 1967, *James L. Reveal & Gerrit Davidse 919*. Holotype deposited at UTC. Isotypes distributed to ARIZ, BRY, CAS, DS, GH, MO, NY, RM, RSA, UC, US, and other herbaria.

DISTRIBUTION. West-central New Mexico from Sandoval and Santa Fe cos. south to Socorro Co. on heavy clay, gypsum, or occasionally sandy soils. Map 3. Flowering mainly in August and September.

SPECIMENS EXAMINED. NEW MEXICO: Sandoval Co., San Ysidro, *Arsene 19424* (P); San Ysidro, *Barneby 12828* (CAS, NY); San Ysidro *Benedict 2255, 2268, 2302* (US); LaVantaua Coal Mine, *Casteller 3756* (NMU); 6 mi NW of San Ysidro, *Reveal & Davidse 925* (BRY, NY, UTC); 4 mi S of San Luis, *Springfield 429* (US, USFS); 4 mi N of San Luis, *Springfield 733* (NMU). Santa Fe Co., 3 mi NE of Los Cerrillos, *Bennett 8222* (TEX); Los Cerrillos, *Herrick 778* (US); 1.8 mi N of Los Cerrillos, *Reveal & Davidse 922* (BRY, NY, UTC). Socorro Co., 7 mi E of San Antonio, *Barneby 12895* (CAS, NY); 3 mi E of San Antonio, *Dunn & Lint 4630* (NMU).

The var. *velutinum* is the large and distinctive form of the species found in west-central New Mexico and thus largely isolated from the rest of the species. Like var. *orbiculatum*, the var. *velutinum* is rather uniform throughout its range even though it occurs

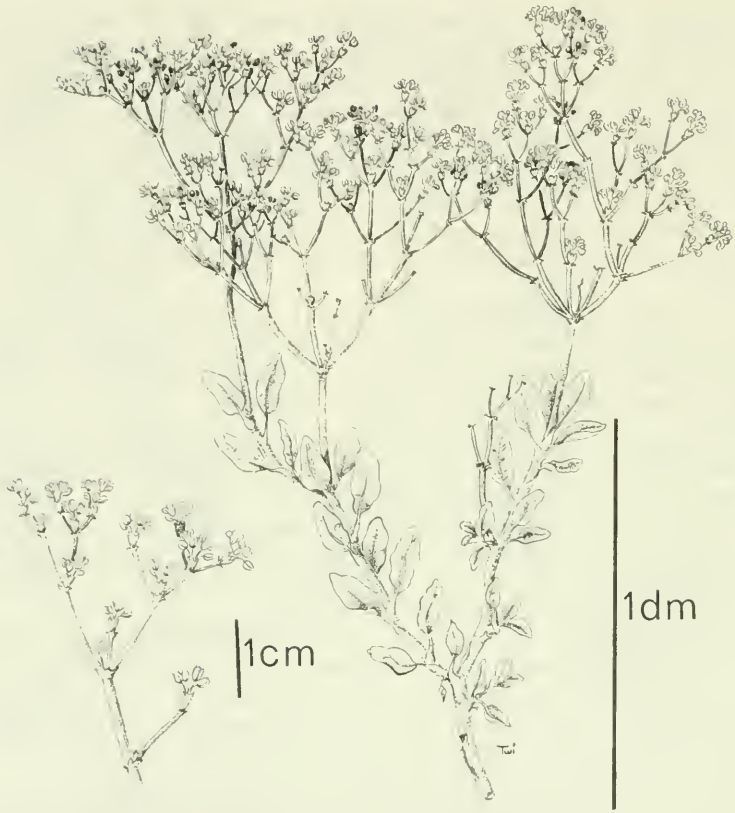


Fig. 14. Habit sketch of *Eriogonum corymbosum* var. *velutinum* showing the general aspect of the plant with an enlarged drawing of part of the inflorescence.

on a wide variety of edaphic conditions. For the most part, the var. *velutinum* is on clay slopes on the low foothills of the mountains, although near Los Cerrillos it is fairly common on sandstone outcrops and northwest of San Ysidro it is usually on gypsum slopes. The plants tend to be most robust on the clay soils and the least robust on the gypsum soils.

In the field, this variety is distinguished by its whitish-brown or whitish-green color of the densely matted tomentose stems and branches and the brownish-white color of the flowers. The plants have rounded crowns, but these are not nearly as dense as the var. *orbiculatum*. This is due to the fact that the branches of var. *velutinum* tend to be more erect and do not normally lay on the ground. The leaves which are spreading, are not as round as var. *orbiculatum*, but tend to be slightly longer than broad. While the tomentum of var. *velutinum* is matted and dense, it is not nearly as soft as var. *davidsei*.

7g. *Eriogonum corymbosum* var. *glutinosum* (M. E. Jones) M. E. Jones, Contr. West. Bot. 11: 14. 1903.

E. aureum M. E. Jones, Proc. Calif. Acad. II, 5: 719. 1895. *E. fruticosum* A. Nels., Bot. Gaz. 34: 23. 1902, a superfluous substitute. *E. microthecum* Nutt. ssp. *aureum* S. Stokes, Gen. Eriog. 76. 1936. (TYPE: St. George, Washington Co., Utah, 28 Sep 1894, *M. E. Jones 6091*. Holotype: POM! Isotypes: MO, NY, UC, US!)

E. aureum var. *glutinosum* M. E. Jones, Proc. Calif. Acad. II, 5: 720. 1895. *E. fruticosum* var. *glutinosum* A. Nels., Bot. Gaz. 34: 23. 1902.

E. crispum L. O. Will., Bull. Torrey Bot. Club 59: 427. 1932. *E. microthecum* Nutt. var. *crispum* S. Stokes, Gen. Eriog. 76. 1936. (TYPE: Cedar Canyon, east of Beaver, Beaver Co., Utah, 2 Sep 1931, *A. O. Garrett 6027*. Holotype: RM! Isotype: UT!)

Subshrubs or shrubs 2-8 (10) dm high, forming large open to compact, hemispheric crowns with few to many divaricated branches; leaves lanceolate to oblanceolate or elliptic, 1-4 cm long, 0.5-1.5 cm wide, the petioles 5-10 mm long; inflorescences cymose, the branches short, glabrous to tomentose, 3-10 cm long; involucres 1-2 mm long, 1-1.5 (2) mm wide; perianth yellow, 1.5-2.5 mm long. Figure 15.

TYPE. ARIZONA: Navajo Co. Holbrook, 22 Aug 1883, *Rusby 808*. Holotype deposited at US! Isotypes: MICH, MO, NY, ORE, UC, US!

DISTRIBUTION. Southwestern and south-central Utah southward to north-central Arizona where it occurs mainly on sandy soils. Map 3. Flowering mainly from late July to early October.

REPRESENTATIVE SPECIMENS. ARIZONA: Apache Co., Petrified Forest N. M., *Borell s.n.* (UC); Chinle, *Demaree 38524* (OKL); Crazy Cr., *Eastwood & Howell 6898* (CAS, US); Adamana, *Rusby s.n.* (NY). Coconino Co., Lee Canyon, *Clover 7241* (MICH); Houserock Valley, *Eastwood & Howell 6482, 6483* (CAS); Metor Crater *Eastwood & Howell 6915* (CAS, US); Sunset Crater, *Gaines 1310, 311, 1312* (WS); Cape Royal, Grand Canyon, *Goodman 6184* (OKL); 20 mi NW of Winslow, *Hall 11178* (UC); Cameron, *Hanson A190* (COLO, MO, NY, OSC); Wupatki N. M., *D. J. Jones 157* (ARIZ, NY), *54-1939* (ARIZ, CAS); Billings, *M. E. Jones 4708* (ARIZ, BM, CAS, COLO, GH, NY, POM, US, UTC); 14 mi W of Cameron, *Kearney & Peebles 12823* (ARIZ, NY, US), *12824, 12825* (ARIZ, US); San Francisco Mts., *Knowlton 217* (GH, US), *249* (US); Sunset Mt., *Purpus 32, 33* (MO, UC, US); Point Sublime, Grand Canyon N. P., *Reveal 695* (ARIZ, BRY, CAS, DS, GH, KANS, MO, NY, OSC, RM, RSA, TEX, UC, US, UT, UTC, WIS); 4 mi N of Cosnino, *Wetherill s.n.* (ARIZ); near Flagstaff, *Whiting 916/3214* (ARIZ, NY). Mohave Co., W of Peach Spr., *Barneby 5005* (CAS, NY); Toroweap, *Cottam 13950* (ARIZ, CAS, UT); 3 mi E of Chloride, *Darrow & Gould 3756* (ARIZ). Navajo Co., Mishongnovi, *Cutler 3101* (DS, NY, OKL); Little Colorado River, *Hough 90* (US); Hopi Indian Res., *Whiting 854/2831* (ARIZ); Holbrook, *Zuck s.n.* (US). UTAH: Beaver Co., 2 mi N of Beaver, *Maguire 17538* (GH, OKL, UC, UTC, WTU), *17539* (OKL, UTC). Garfield Co., 8 mi NE of Henrieville, *Cottam 14112* (POM, UT); 20 mi SW of Escalante, *Holmgren et al. 2413* (BRY, CAS, GH, MO, NY, OSC, RM, RSA, TEX, UC, US, UT, UTC); near Widtsoe, *Smith s.n.* (UTC). Iron Co., 8.7 mi SE of Cedar City, *Dress 4758* (BM); 10 mi E of Cedar City, *Hitchcock et al. 4621* (CAS, DS, ISC, MONTU, NY, OKL, POM, RSA, UC, US, UTC, WS, WTU); 5 mi E of Cedar City, *Maguire & Richards 13292* (GH, UC, UTC). Washington Co., Zion N. P., *Bacigalupi 2799* (CAS, DS, RSA); Gunlock, *Cottam 5358* (BRY, UT); Beaver Dam Mts., *East-*

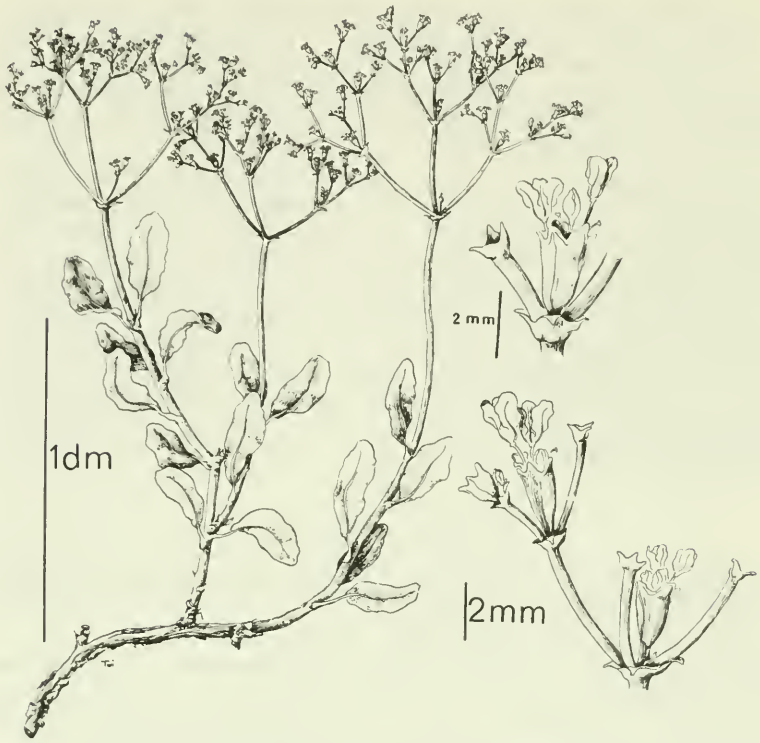


Fig. 15. Habit sketch of *Eriogonum corymbosum* var. *glutinosum* showing the general aspect of the plant with enlarged drawings of the inflorescence and an involucre with exserted flowers.

wood & Howell 6318 (CAS, DS, UC); Jackson Road, *Higgins 810* (BRY); 1 mi N of Hurricane, *Maguire & Blood 4374* (GH, UC, UTC); St. George, *Palmer 6787* (BM. MO. NY); 5 mi W of Santa Clara, *Reveal & Reveal 586* (CAS, MO, UTC).

The distinction of *E. corymbosum* var. *corymbosum* and var. *glutinosum* has been discussed previously under var. *corymbosum*, and the only point that needs to be noted here is that the area of overlap between the two forms is small, and thus the distinction presented here is valid. While some mixed populations (such as that west of Cameron, Coconino Co., Arizona) seem to be separated only on flower color, the vast majority of specimens present no problems. As the var. *glutinosum* occupies a distinct geographical area and can be separated by morphological characteristics, it is recognized at the varietal level.

When Jones (1895) described *E. aureum*, he recognized two varieties. Two of the taxa proposed, *E. aureum* and the var. *glutinosum*, are the same kind of plant, and when he recognized this in 1903, Jones reduced the species to a variety of *E. corymbosum*. The third taxon, var. *ambiguum*, however, is the yellow-flowered form

of *E. microthecum* from the southern Sierra Nevada, and this has only been recently noted by Reveal (In Munz, in press). Stokes must have based the concept of her "ssp. *aureum*" to a large degree on the Sierra Nevada material as she placed this taxon under *E. microthecum* rather than under *E. effusum* Nutt. where the remainder of the *E. corymbosum* complex had been placed.

Jones distinguished the var. *aureum* from the var. *glutinosum* on the basis that the first had glabrous stems while the second had tomentose stems. This distinction does not seem to be of much importance here, a conclusion that Jones reached some years ago.

In the field, var. *glutinosum* occurs in a wide variety of habitats. In the St. George, Washington Co., Utah area, and to some degree, to the south, the variety occurs on sandy soils. In the Grand Canyon it may be found clinging to the canyon walls. In much of its Utah range, it occurs among broken rocks and ledges in protected areas, unlike var. *corymbosum* which is usually found in the more open sites and on clay hills.

Literature Cited

Brotherson, J. D. 1967. A study of community relationships of *Eriogonum corymbosum* Benth. in DC. in Uintah Basin, Utah. Unpublished master's thesis, Brigham Young University.

Davis, R. J. 1952. Flora of Idaho. Dubuque, Iowa.

Gandoger, M. 1906. Le genere *Eriogonum* (Polygonaceae). Bull. Soc. Bot. Belg. 42:183-200.

Gray, A. 1876. Miscellaneous botanical contributions. Proc. Amer. Acad. 11: 71-104.

Hanson, C. A. 1962. Perennial *Atriplex* of Utah and the northern deserts. Unpublished master's thesis, Brigham Young University.

Holmgren, A. H. 1962. The vascular plants of the Dinosaur National Monument. Utah State University, Logan, Utah.

Jones, M. E. 1895. Contributions of Western Botany. No. VII. Proc. Calif. Acad. Sci. II, 5:611-733.

———. 1903. *Eriogonum*. Contr. West. Bot. 11:4-18.

Lanjouw, J. et al., editors. 1966. International Code of Botanical Nomenclature. Regnum Vegetabile vol. 46. Utrecht, Netherlands.

——— & F. A. Stafleu. 1964. Index Herbariorum. 5th Edition. Regnum Vegetabile vol. 31. Utrecht, Netherlands.

Nelson, A. 1902. Contribution from the Rocky Mountain Herbarium. III. Bot. Gaz. 34:21-35.

———. 1904. New plants from Wyoming. XV. Bull. Torrey Bot. Club 31: 239-247.

Reveal, J. L. In press a. New species of *Eriogonum* from Utah. Madroño.

———. In press b. A new annual *Eriogonum* from Utah. Ann. Mo. Bot. Gard.

———. In press c. *Eriogonum jonesii* S. Wats. Southwest. Nat.

———. IN: MUNZ, P. A., in press. *Eriogonum*. Supplement to A California Flora. University of California Press, Berkeley.

Rydberg, P. A. 1912. Studies on the Rocky Mountain flora. XVII. Bull. Torrey Bot. Club 39:301-328.

———. 1917. Flora of the Rocky Mountains and adjacent Plains. New York, New York.

Small, J. K. 1906. Studies in North American Polygonaceae. II. Bull. Torrey Bot. Club 33:51-57.

Stokes, S. G. 1936. The genus *Eriogonum*, a preliminary study based on geographic distribution. San Francisco, California.

———. 1943. Further studies in *Eriogonum*. V. Leafl. West. Bot. 3:200-202.

Tidestrom, I. T. 1925. Flora of Utah and Nevada. Contr. U. S. Nat. Herb. 25:1-665.

Torrey, J. & A. Gray. 1857. Botany in: *E. G. BECKWITH*. Report of explorations for a route for the Pacific railroad, on the line of the forty-first parallel on north latitude. 2:115-132.

———. 1870. A revision of the Eriogoneae. Proc. Amer. Acad. 8:145-200.

Welsh, S. L. 1957. An ecological survey of the vegetation of the Dinosaur National Monument, Utah. Unpublished master's thesis, Brigham Young University.

——— & E. M. Christensen. 1957. An ecological study of the vegetation of the Dinosaur National Monument. Proc. Utah Acad. 34:55-56.

Williams, L. O. 1932. Field and herbarium studies. I. Bull. Torrey Bot. Club 59:427-429.

Wooton, E. & P. C. Standley. 1913. Descriptions of new plants preliminary to a report upon the flora of New Mexico. Contr. U. S. Nat. Herb. 16:109-196.

D ELDEN BECK (1906-1967)

Vasco M. Tanner[1]

D Elden Beck, the son of Mitchel Robertson and Ruth Davis Beck, was born at Spanish Fork, Utah, April 11, 1906, and died August 9, 1967 at Provo, Utah. He married May 31, 1933, Florence Robinson, of Provo, Utah. Four children were born to this couple: Janet (Mrs. Jon G. Clark); Brent Robinson; Linda (Mrs. R. Brent Bullough) all of Provo, and Larry Robinson of Magna, Utah. Professor Beck's father was a descendant from John Forsyth Beck who came to Utah in 1850 from Freehold Township, Buck County, Pennsylvania. His mother was the daughter of Charles Augustas Davis who emigrated from Boston, Massachusetts, to Utah in 1849. Elden's parents were married in 1904 and resided in Spanish Fork and environs until 1914 when for economic reasons, they moved to McGill, Nevada, where his father was employed at the mines. Young Beck began his grade school work there. Life in a mining camp was new and different. In his boy scout activities, he mingled with youngsters from families of many nationalities. He with his pals explored the region round-about engaging in boyish pranks, camping, target practicing, collecting insects, rocks, plants, pine nuts, and animals.

As World War I ended, mining operations dropped off and the Beck family was numbered among the many to leave McGill in 1921. The move took them to Lava Hot Springs, Idaho, where they engaged in road construction work and farming. Here they were in a new environment for the fifteen-year-old lad who was beginning to manifest an interest in nature. The meadows, Portneuf River, and hot mineral springs were new and challenging conditions to him. He often remarked that Roscoe E. Davis, a teacher in the high school at Lava Hot Springs, was an inspiration to him. They went into the fields together collecting plants, animals, and rocks, but above all, Davis encouraged Elden to continue his education after graduation from high school.

When Beck graduated from the Lava Hot Springs High School in 1925, he began preparation to enter the Brigham Young University. In his freshman year he elected to take courses in chemistry and general zoology which gave him an introduction to the sciences. Due to lack of funds, he lived in Spanish Fork with his grandmother Matley (on his mother's side), and commuted each day on the electric interurban train, a distance of 12 miles. In his sophomore year, he batched in Provo with Fred Rowland, a classmate and chum from Lava Hot Springs, until January when due to the death of his grandfather Davis in Spanish Fork, he decided to help his grandmother by staying with her and commuted to Provo. At the University, he

1. Professor of Zoology and Entomology, Brigham Young University, Provo, Utah.

D Elden Beck, entomologist, invertebrate zoologist, Brigham Young University, 1938-1967.

had become deeply interested in entomology. He arrived early at the laboratory and was one of the last to leave at night. Laboratory life was still in the tradition of close contact between teacher and student, and the activities of teaching and research were still so closely allied that intellectual relations struck root deeply. At any rate, the teachers and students with whom Elden Beck worked in this period of his career had a powerful influence in bringing out his latent possibilities and ripening his inclination toward natural history. Such classmates as Clarence Cottam, C. J. D. Brown, Irvin

Rasmussen, C. Lynn Hayward, W. Thalman Hasler, Allen Rowe, and Wilford Olsen continued their graduate studies and all have been awarded Ph.D. degrees in zoology or entomology. During Elden's first year at the University, his social and athletic activities were neglected. To compensate for this, he enlisted and served for three years in the Medical Corps of the National Guard.

In the summer of 1928, Beck was chosen to participate in the third biology field expedition. A group of five—Fred Richan, Elden Beck, Orlin Biddulph, advanced biology students, under the direction of Drs. Vasco M. Tanner and Walter P. Cottam, spent six weeks in field survey and collecting in southern Idaho, and along the Utah-Nevada state line to the St. George region. Beck enjoyed this very much as he was an excellent collector and field student. During his senior and graduate years, he was a laboratory instructor in general zoology. In 1929 he was awarded the Bachelor of Arts degree and in 1930 a Master of Arts degree in zoology and entomology. His outlook on life was enlarged when in the spring of 1930 he was granted a research assistantship in entomology at Iowa State College, Ames, Iowa. The next three years were spent in graduate study with Drs. Drake, Wellhouse, Harris, Knight and Richardson. Elden also had the following Utah student friends with whom he associated at Ames: Francis Mortenson, Arvil Stark, Ara Call, Quinten Anderson, Delbert Greenwood, and staff members Drs. C. Y. Cannon and Rudger Walker.

During most of the summer vacation in 1931, Beck and Ara Call collected insects in Kansas, Oklahoma, New Mexico, Northern Mexico from El Paso to Casas Grandes, Magdalena, and Nogales. This collection was shared with the entomologists at Iowa State College and Brigham Young University.

The year 1933 was important in the life of D E. Beck. In the spring of the year he was appointed head of the Biology Department at Dixie College; he and Florence Robinson were married on May 31; and in June he was awarded the Ph.D. degree.

Beck finished his class work and thesis—*A Morphological Study of the Male Genitalia of Various Genera of Bees* and was graduated with a Ph.D. degree from the Department of Entomology at Iowa State College (now Iowa State University) in June 1933. This same year he was appointed head of the Department of Biology at Dixie College, St. George, Utah. This position was made vacant by the death of Dr. William Harrison, a Brigham Young University alumnus, who had recently graduated from Iowa State College, with a Ph.D. degree in biology; Dr. Harrison was a very good teacher and community worker. President Joseph K. Nicholes of the college was anxious to fill this position with an equally promising candidate.

Dr. Beck soon ingratiated himself with the students and the people of the community. He went to considerable effort to take his students on field trips in order that he might lead them into a first-hand acquaintance with the flora and fauna of the St. George area. His trip into Mexico in 1931 so fascinated him that he ventured again in the summer of 1934 to spend six weeks collecting in North-

ern Sonora as well as on the plateau area around Mexico City. This collecting party consisted of his wife Florence and a student, Floyd Atkin. Their bounteous collection of insects and reptiles was used to great advantage in teaching.

Elden's artistic and helpful wife, Florence, while studying art with Mr. Ralph Huntman, artist at the college, persuaded him to try landscape painting which resulted in his interest in painting and the organization in 1934 of a Fine Arts Festival at the college, which has continued to the present time.

An opportunity to return to his alma mater, the Brigham Young University, as assistant professor of zoology and entomology was embraced in 1938. Dr. Beck's addition to the zoology staff was welcomed since he added impetus to field biology study, development of an enlarged program in invertebrate zoology, and research. In 1942, he wrote a laboratory guide for general zoology now in the 4th edition (Burgess Publishing Company).

World War II beckoned Dr. Beck to volunteer and serve in the Medical Entomological Service. His first assignment was at Camp Barkley, Abilene, Texas. (April 1943 - July 4, 1943) for basic training at the Medical Replacement Training Center. On July 4, 1943, he was transferred to Fort McPherson and Fort Benning, Georgia, for mosquito survey and control work. Here he remained until December 11, 1943, when he was again transferred this time to Camp Ellis, Illinois. At this camp a malaria survey unit was organized with Lieutenant Beck in command. On January 14, 1944, he left for Camp Plauche near New Orleans, Louisiana, to receive training preparatory to going over seas. He set sail from San Francisco April 20, 1944, arriving in Guadalcanal, Solomon Islands, on May 19, 1944. During the year of continental service, Lieutenant Beck made valuable collections of insects, amphibians, and reptiles in Texas, Georgia, and Louisiana, which he sent back to the University at Provo.

Collecting had long been a passion with Dr. Beck. During the twelve months—May 19, 1944 to May 22, 1945—spent on Guadalcanal, aside from the duties as director of mosquito control activities at the 20th Station Hospital on the Tenaru River where he distinguished himself in this capacity, he did considerable collecting of insects and reptiles. He not only collected several hundred frogs, lizards, and snakes, but he made a large general collection of most of the insect orders. These specimens were so well prepared for shipping that very little loss resulted from breakage and damage. All the collecting was done within a radius of five miles of the hospital. This area is in the low, sloping plains consisting of swamps, grasslands, and jungles. All of the specimens collected by him were sent to the Brigham Young University where the writer, with student help, spent much time pinning, labeling, and preserving the thousands of specimens he collected.[2] Dr. Beck not only worked

2. Vasco M. Tanner, 1948. *Pacific Islands Herpetology* No. 1. - Mariana Islands. *Great Basin Naturalist*, Vol. IX, Nos. 1-2, pp. 1-20, 1951. *Pacific Islands Herpetology*, No. V - Guadalcanal, Solomon Islands: A Check List of Species. Vol. XI, Nos. 3-4, pp. 53-86.

hard as a collector but he directed the efforts of many students in that war area in their collecting and shipping of specimens to the Brigham Young University. Some of the University alumni members who cooperated with Dr. Beck in this project were Ernest Reimschüssel, Doyle Taylor, Cluff Hopla, and Herbert Frost. Weevils of the tribe Celeuthetini he collected have served as a nucleus for a critical study of the species of five genera found in the Solomon Islands.

On May 22, 1945, Captain Beck (Lieutenant Beck was promoted to Captain in February 1945) returned to the United States, and arrived in San Francisco on June 19, 1945. From here he was sent to Camp Carson General Hospital in Colorado where he received medical care until October 10, 1945, when he was honorably discharged to return to his wife and family. Florence, his faithful and efficient wife, and four children had, with the help of members of her family and friends, carried on in a stoic manner. Her worries, loneliness, and heartfelt anxiety for Elden's safety and whole return were gallantly borne.

The experience gained in mosquito control methods during the war was put to good use by Dr. Beck. He was assigned by the Utah County Commission and Health Department in 1946-47 to develop a mosquito control program for Utah County. He was also active in civic affairs serving as President of the Provo Junior Chamber of Commerce. For his service he was awarded the distinguished service award by this organization in 1947. He was also editor of the Provo, Utah, Centennial Souvenir 1849-1949.

In 1951-52 Elden was granted a sabbatical leave from the University for the purpose of doing research work at the American Museum of Natural History, New York City. Here his contact with Libby Hyman, great authority on invertebrate zoology, was invaluable. Several months were also spent at Lake Placid, Florida, where he became acquainted with Dr. James G. Needham. A first edition of an invertebrate zoology laboratory guide was finished at this time. A second and third edition of this manual with Dr. Lee Braithwaite as co-author has been widely adopted by more than 200 colleges and universities of the United States.

Dr. Beck began making a collection of earthworms about 1948, since he was aware of the lack of in depth knowledge of the earthworms fauna of the western United States. He sent his collection of these worms to the American Museum of Natural History, New York City. Dr. G. E. Gates, University of Maine, Orono, Maine, authority on earthworms of the United States, graciously decided to study Beck's collection. His recently published paper dealing with *The Earthworm Fauna of the Great American Desert and Adjacent Areas*[3] is based largely upon Dr. Beck's collection. In a letter to the writer (October 16, 1967) Dr. Gates comments as follows on Beck's earthworm collection and his (Gates) article referred to above. "Data from study of Beck's earthworms will be appearing from time

3. G. E. Gates, 1967. The Earthworm Fauna of the Great American Desert and Adjacent Areas. Great Basin Naturalist, Vol. 27, No. 3, pp. 142-176.

to time in various contributions, but such data will largely be incidental and not of the importance that it derives from the Great Basin collections. In a sense, then, I suppose, that this contribution will be a sort of memorial—at least to his collecting of megadriles. A second regret *re* of Beck's work is that one shipment of his earthworm material got lost somewhere (he never knew where or how) and never reached the American Museum to which he had been sending his collection. The lot or lots probably would have made the MS. even more massive."

In 1951 he received a grant from the National Institutes of Health for a study of the ectoparasites of the mammals of the western United States. Many small mammals were trapped in Utah, Arizona, and Idaho from which Beck obtained a large collection of fleas and ticks.

Dr. Beck's recognized success in mosquito control gained for him a leave from university duties 1956-1958 to serve as an adviser under the auspices of the World Health Organization on malaria mosquito control for the Chinese government in Tiawan. Mrs. Beck and some of the children accompanied him. While there, he made a lifelong friend of Dr. Hsieh, parasitologist, who is now engaged as a parasitologist at Harbel, Liberia, West Africa.

Dr. Beck was advanced to Professor of Zoology and Entomology and made chairman of the department at Brigham Young University, serving from February 1962 to June 1965. During his chairmanship new staff members were added and the department increased in enrollment and facilities.

From 1959-1966 Dr. Beck was associated with Dr. Dorald Allred, associate professor of zoology and entomology at Brigham Young University, in an ecological study at the Nevada Test Site as principal investigator 1964-66 and associate investigator 1959-64. This study was carried forward under an Atomic Energy Commission grant. The main object of the research project was to make a faunistic inventory of the test site. Many specialists have been involved in studying the specimens collected by a staff of collectors who worked under the supervision of Beck and Allred. More than 70 papers have been published dealing with the invertebrates, vertebrates, and the ecology of the test site.

Two of the papers merit comment at this time. *The Orthoptera of the Nevada Test Site*,[4] by Andrew H. Barnum, at Dixie College, 1964, is a noteworthy contribution. In this study approximately 8,000 specimens of Orthoptera were collected and studied. Species from four of the five recognized suborders, 9 families, 41 genera, and 60 species are recognized in the study. There are 157 well-executed morphological figures, 34 distribution maps, along with keys and description to the taxa involved. This contribution of 134 pages adds greatly to the knowledge of the American Desert Orthoptera of the Great Basin. Two species of camel crickets are described as new to science.

4. Andrew H. Barnum, 1964, *Orthoptera of the Nevada Test Site*. Brigham Young University Science Bulletin; Biological Series - Vol. IV, No. 3, pp. 1-134.

The *magnum opus* of these publications is one by Dr. Harry H. Knight, entomologist at Iowa State University, Ames, Iowa. This study now in press is a *Taxonomic Review: Miridae (Hemiptera) of the Nevada Test Site and Western United States.* It is an exhaustive treatise of the mirids of the test site and the western United States. Dr. Knight has put forth great effort in dealing with the 612 species and 122 genera covered in this study. He has recognized 160 species and 50 genera as occurring on the Nevada test site; of which 3 genera and 96 species are described as new to science.

Dr. Beck is honored by Dr. Knight with the following new genus *Beckocoris laticephalus*, and five new species as follows: *Chlamydatus becki; Nevadocoris becki* (this is a new genus); *Lopidea becki; Parthenicus becki;* and *Phytocoris becki.* This volume is dedicated to the memory of Dr. D Elden Beck.

Great credit is due Drs. Beck and Allred for the success achieved in accomplishing the main objective of the research project. Much more is now known about the fauna of the Great Basin than 10 years ago before the initiation of this project.

Dr. Beck was active in the following learned societies: Society of Sigma Xi; Utah Academy of Sciences, Arts, and Letters; American Society of Parasitologists; American Wildlife Disease Association; American Mosquito Control Association; and Utah Mosquito Abatement Association.

We should not neglect to report that Professor Beck was an avid and talented photographer. His photographic files contain more than a thousand negatives of plants, animals, and geological features, many of which have been published in national magazines.

D E. Beck was proud of his family. His 11 grandchildren were anxious to visit their grandfather and were always welcomed into the well-ordered Beck home. Elden met people easily with a ready and even voluble speech and he possessed a charm of manner that made him good company. The instinct to help others seems to have been one of Dr. Beck's most deep-seated characteristics. He went beyond a willingness to lend a sympathetic ear, to lend a hand to friends and students alike. His artistic soul drank in the beauty of the seasonal changes of mountain, stream, and valley. He was in harmony with the animate and inanimate make-up of his environment. The color of man did not wean him from the inner warmth and spirit beneath the human skin. He had an abiding faith in the justice and power of his Maker. We will miss, but long remember our colleague and friend D Elden Beck.

The Following Comprise the Principal Articles (63) Published by Professor Beck on Scientific Subjects, 1929-1967

1929

Bees of the Sub-family *Osminae* in the collection of the BYU Zoology Dept. *Bull. Brooklyn Ent. Soc.*, Vol. 24, pp. 303-306, 1929.

1931

Length of the Developmental Stages of the Horn-fly *Haemotobia irritans* at Constant Temperature. *Jour. Economic Ent.*, Vol. 24, 1931.

1933
A Morphological Study of the Male Genitalia of Various Genera of Bees. *Proc. Utah Acad. of Sci.*, Vol. 10, pp. 89-137, 1933.

1935
The Place of Physiology and Hygiene in the Secondary Curriculum. *Utah Ed Review.*, Vol. 28, pp. 279-280, 1935.

1936
Notes on Utah Water Striders. *Proc. Utah Acad. of Sci., Arts, Lett.*, Vol. 13, pp. 203-206, 1936.

1937
Capitol Reef. *Utah Mag.*, Vol. 2, No. 19, pp. 6, 15, and 20, 1937.

1939
Social Hygiene. *Utah Ed. Rev.*, Vol. 32, pp. 174-186, 1939.

1942
Life History Notes on the California Gull, No. 1. *Great Basin Naturalist*, Vol. 3, Nos. 3 - 4, pp. 91-108, 1942.
Gull Banding Notes at Utah Lake, No. 2. *Great Basin Naturalist*, Vol. 3, pp. 55-57, 1942. Junior co-author with Vasco M. Tanner.

1943
Coyote Gulch. *Improvement Era*, Vol. 4, No. 8, pp. 462-463, 503, 1943.
California Gull - A Comparative Plumage Study. *Great Basin Naturalist*, Vol. 4, pp. 57-61, 1943.

1946
Down the Escalante. *Utah Mag.*, Vol. 8, No. 4, pp. 24, 34, 45, 49-50; No. 5, pp. 32-33, 48; No. 6, pp. 30, 45-47; No. 7, pp. 30-31, 42, 44; No. 8, pp. 30-31, 33, 36-37; No. 9, pp. 30-31, 43-44. (Booklet run as a serial, 1946.)

1947
The Seagull in Utah. *Utah Mag.*, Vol. 9, No. 4, pp. 22-25, 1947.

1949
Provo, Centennial Booklet. (Editor, and feature articles author) Published by Provo City, Lorraine Press Printers, Salt Lake City, Utah, pp. 1-75, 1949.

1951
Some Observations on Biology Instructions in Secondary Schools. Proceedings Eighth Annual Conference on Higher Education: Utah Conferences on Higher Education. September 1951.

1953
Mite Fauna of Woodrat Nests in Utah. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 30, pp. 53-56, 1953. Junior co-author with Dorald M. Allred.
Arthropod Consortes Found in the Nests of *Neotoma cinera acraia* (Ord) and *Neotoma lepida lepida* Thomas. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 30, pp. 43-52, 1953. Senior co-author with A. H. Barnum and Lenard Moore.
A Study of Some Consortes Found at a Nesting Site of the Northern Cliff Swallow *Petrochelidon albifrons albifrons* (Rafinesque). *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 30, pp. 39-42, 1953.
A New Species of *Acomatacarus* (Acarina, Trombiculidae) from Utah. *Great Basin Naturalist*, Vol. 13, Nos. 3 - 4, 1953. Junior co-author with Dorald M. Allred.
Plague, Plague Distribution and Plague Vectors in Utah. *Seventieth Annual Sigma Xi Address. BYU Chap. Proc.*, 1953.

1954
Ecological and Distributional Notes on Some Utah Hirudinea. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 31, pp. 73-78, 1954.
Distributional Records of Some Aquatic Coleoptera in Utah. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 31, pp. 52-56, 1954.
Distributional and Natural History Notes on *Polycelis coronata* in Utah. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 31, pp. 79-82, 1954.

1955
Potential and Capable Vectors of Rocky Mountain Spotted Fever and Plague in Utah. *BYU Sci. Bull., Biological Series*, Vol. 1, No. 1, pp. 1-64, February, 1955.

Some Unusual Distributional Records of Ticks in Utah. *Jour. of Parasitology*, Vol. 4-1, No. 2, pp. 1-4, 1955.

The Chiggers of Utah (Acarina: Trombiculidae). *Great Basin Naturalist*, Vol. 15, Nos. 1-4, pp. 1-26, 1955. Junior co-author with James M. Brennan.

Seasonal Study of the Tick, *Ornithodoros hermsi* found in nests of the Desert Wood Rat, *Neotoma lepida lepida* in Utah. *Proc., Utah Acad.*, Vol. 32, pp. 131-135. 1955. Senior co-author with Dorald M. Allred.

1957

Seasonal Population Fluctuations of Mites in Desert Wood Rat Nests in Central Utah. *Ecology*, Vol. 38, No. 1, 1957.

1958

Zoology of the Upper Colorado River Basin. 1. Biotic Communities. *BYU Sci. Bull., Biological Series*, Vol. 1, No. 3, pp. 1-74, 1958. Junior co-author with C. L. Hayward and W. W. Tanner.

Malaria Control and Eradication in Taiwan (Formosa, China). *Progress Report*, 1952-1957. (Co-author). *Bull. World Health Org. 19.*, 1958.

1960

Ticks of the genus *Ixodes* in Utah. *BYU Sci. Bull., Biological Series*, Vol. 1, No. 4, pp. 1-42, 1960. Junior co-author with Dorald M. Allred and L. D. White.

Mosquito Survey of Central Utah Valley, Utah. *Proc., Thirteenth Annual Meeting of the Utah Mosquito Abatement Assoc.*, 1960.

Central Utah County Mosquito Survey Studies. *Mosquito News*, Vol. 21, No. 1, pp. 6-11, 1960.

Invertebrate Zoology Laboratory Workbook. *Burgess Publishing Co.*, Minneapolis, Minnesota, 1960. Second Edition, pp. 1-289, 1962. Senior co-author with L. F. Braithwaite.

Comparative Ecological Studies of Animals Exposed to Nuclear Detonation. (abstract) *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 37, pp. 152-153, 1960. Junior co-author with D. M. Allred and J. R. Murdock.

1962

Ecological Distribution of Mites on Lizards at the Nevada Atomic Test Site. *Herpetologica*, Vol. 18, pp. 47-51, 1962. Junior co-author with D. M. Allred.

1963

Ecological Distribution of some Rodents at the Nevada Atomic Test Site. *Ecology*, Vol. 44, No. 1, pp. 211-214, 1963. Junior co-author with D. M. Allred.

Comparative Ecological Studies of Animals at the Nevada Test Site. *Proc., 1st Nat. Symposium on Radioecology*. Reinhold Publ. Corp., pp. 327-331, 1963. Junior co-author with D. M. Allred.

Range of Movement and Dispersal of Some Rodents at the Nevada Atomic Test Site. *Jour. of Mammalogy*, Vol. 44, No. 2, pp. 190-200, 1963. Junior co-author with Dorald M. Allred.

Ticks of the Nevada Test Site. *BYU Sci. Bull., Biological Series*, Vol. 4, No. 1, pp. 1-11, 1963. Senior co-author with D. M. Allred and Elias P. Brinton.

Some Effects of an Underground Nuclear Detonation on Biotic Communities at the Nevada Test Site. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 40, pp. 49-61, 1963. Co-author with D. M. Allred and C. D. Jorgensen.

Nevada Test Site Study Areas and Specimen Depositories. *BYU Sci. Bull., Biological Series*, Vol. 2, No. 4, pp. 1-15, 1963. Co-author with D. M. Allred and C. D. Jorgensen.

Biotic Communities of the Nevada Test Site. *BYU Sci. Bull.*, Vol. 2, No. 2, pp. 1-52, 1963. Co-author with D. M. Allred and C. D. Jorgensen.

Hard Bodied Ticks of the Western United States. *BYU Sci. Bull.*, Vol. 2, Part 1, No. 3, pp. 1-28, 1963. Co-author with Elias P. Brinton.

Hard Bodied Ticks of the Western United States. *BYU Sci. Bull.*, Vol 2, Parts 2 - 3, No. 3, pp. 1-21, 1963. Co-author with Elias P. Brinton.

Comparative Ecological Studies of Animals at the Nevada Test Site with Specific Reference to Their Reaction to Exposures of Nuclear Effects.

Junior co-author with Dorald M. Allred. Off site Ecological Research of the Division of Biology and Medicine - Terrestrial and Freshwater, U. S. Atomic Energy Commission, March 1963, pp. 4-6. TID-13358. Edited by Vincent Schultz.

Mites from Pocket Mice at the Nevada Test Site. *Proc. Ent. Soc. Wash.*, Vol. 65, No. 3, pp. 231-233, 1963. Junior co-author with D. M. Allred.

1964

Mites on Reptiles at the Nevada Atomic Test Site. *Trans. Am. Microscropical Soc.*, Vol. 83, No. 2, pp. 266-268, 1964. Co-author with D. M. Allred.

Observations on Host-Parasite Relationships and Seasonal History of Ticks in San Mateo County, California. *Great Basin Naturalist*, Vol. 24, No. 1, pp. 1-6, 1964. Junior co-author with Carol O. Mohr and Elias P. Brinton.

Arthropod Associates of Plants at the Nevada Test Site. *BYU Sci. Bull., Biological Series*, Vol. 5, No. 2, pp. 1-16, 1964. Junior co-author with Dorald M. Allred.

Close-in Effects of an Underground Nuclear Detonation on Small Mammals and Selected Invertebrates. Report PNE-266F; Washington: Office of Technical Services, U. S. Dept. of Commerce, 22 pp. FINAL REPORT. 1964. Co-author with D. M. Allred and C. D. Jorgensen.

1965

A List of Scarabaeidae Beetles of the Nevada Test Site. *Great Basin Naturalist*, Vol. 25, Nos. 3-4, 1965. Junior co-author with D. M. Allred.

A List of Some Beeflies of the Nevada Test Site. *Great Basin Naturalist*, Vol. 25, Nos. 1-2, pp. 5-11, 1965. Co-author with D. M. Allred and E. Johnson.

Ecological Effects of Nuclear Testing on Native Animals at the Nevada Test Site. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 42, Part 2, 1965. Co-author with D. M. Allred and C. D. Jorgensen.

Identification of the Adults, Nymphs, and Larvae of Ticks in the Genus *Dermacentor koch* (Ixodidae) in the Western United States. *BYU Sci. Bull., Biological Series*, Vol. 5, No. 4, pp. 1-44, 1965. Co-author with E. P. Brinton and D. M. Allred.

Nevada Test Site Desert Ecology. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 41, No. 2, pp. 202-209, 1965. D E. Beck et al.

Some Variables to Consider in Field Collections Which Will Affect the Interpretation of Animal Population Data for Parasitic Arthropods. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 42, Part 1, pp. 56-59, 1965.

1966

Mites of Utah Mammals. *BYU Sci. Bull.*, Vol. 8, No. 1, pp. 1-123, 1966. Junior co-author with D. M. Allred.

Siphonaptera (Fleas) of the Nevada Test Site. *BYU Bull.*, Vol. 7, No. 2, pp. 1-27, 1966. Senior co-author with D. M. Allred.

Summary of the Ecological Effects of Nuclear Testing on Native Animals at the Nevada Test Site. *Proc., Utah Acad. Sci., Arts, Lett.*, Vol. 42, No. 2, pp. 252-260, 1966. Co-author with D. M. Allred and C. D. Jorgensen.

Tingidae, Neididae (Berytidae and Pentatomidae) of the Nevada Test Site. *Great Basin Naturalist*, Vol. 26, No. 1-2, pp. 9-16, 1966. Junior co-author with D. M. Allred.

1967

Predaceous - Scavenger Ants in Utah. *Great Basin Naturalist*, Vol. 27, No. 2, pp. 67-78, 1967. Co-author with D. M. Allred and W. J. Despain.

General Zoology Syllabus. *Laboratory Workbook*, Burgess Publishing Co., pp. 1-165. Minneapolis, Minnesota, 4th Edition, 1967.

INDEX TO VOLUME XXVII

The new genera, species, and varieties in this volume appear in bold type in this index.

A Comparative Study of the Mountain Brush Vegetation in Utah, p. 59.
Allred, Dorald M. and D Elden Beck, Article by, p. 11.
Amphicranus **quercus,** p. 53.
A. **rameus,** p. 55.
A New Name for a Utah Lepidium, p. 177.
A New Species of Spinibdella from Utah (Bdellidae: Acarina), p. 98.
Beck, D Elden, Dorald M. Allred, and William J. Despain, Article by, 67.
Cactopinus **mexicanus,** p. 37.
Chaetophloeus **minimus,** p. 95.
C. **struthanthi,** p. 96.
Chramesus **bicolor,** p. 91.
C. **demissus,** p. 93.
C. **incomptus,** p. 90.
C. **punctatus,** p. 94.
C. **vastus,** p. 92.
Cnesinus **adusticus,** p. 87.
C. **annectens,** p. 86.
C. **bicornus,** p. 80.
C. **carinatus,** p. 88.
C. **colombianus,** p. 84.
C. **electinus,** p. 82.
C. **elegantis,** p. 79.
C. **foratus,** p. 81.
C. **myelitis,** p. 84.
C. **niger,** p. 83.
C. **retifer,** p. 85.
Corthylus **petilus,** p. 56.
C. **splendens,** p. 138.
D Elden Beck (1906-1967), p. 230.
Eriogonus pauciflorum var. **gnaphalodes** (Benth. in Hook.) Reveal, stat. & comb. nov., p. 112.
E. p. var. canum (S. Stokes) Reveal, stat. & comb. nov., p. 112.
E. p. var. **nebraskense** (Rydb.) Reveal, stat. & comb. nov., p. 113.
E. p. var. canum (S. Stokes) Reveal, stat. & comb. nov., p. 114.
E. **exilifolium** Reveal, p. 114.
Eriogonum corymbosum, Benth. in DC., p. 205.
E. c. var. **albogilvum,** Reveal, p. 218.
E. c. var. **corymbosum,** p. 207.
E. c. var. **davidsei,** Reveal, p. 216.
E. c. var. **erectum,** Reveal & Brotherson, p. 213.
E. c. var. **glutinosum,** M. E. Jones, p. 226.
E. c. var. **orbiculatum** (S. Stokes) Reveal & Brotherson, stat. & comb. nov., p. 221.
E. c. var. **velutinum,** Reveal, p. 224.
E. **duchesnense,** Reveal, p. 194.
E. fendlerianum, Benth, in DC., p. 199.
E. **hylophilum,** Reveal & Brotherson, p. 190.
E. **lancifolium,** Reveal & Brotherson, p. 187.
E. **saurinum,** Reveal, p. 196.
E. **smithii,** Reveal, p. 202.
Gates, G. E., Articles by, p. 1, 142.
Gist, Clayton S., Article by, p. 26.
Gnathotrichus **dentatus,** p. 45.
G. **imitans,** p. 48.
G. **nimifrons,** p. 47.
G. **perniciosus,** p. 47.
Hylastes **mexicanus,** p. 36.
Jorgensen, Clive D., Article by, p. 98.
Leperisinus **guatemalensis,** p. 89.
Lepidium **barnebyanum,** Reveal, nom. nov., p. 178.
Loganius **exilis,** p. 119.
Microcorthylus **desus,** p. 52.
Monarthrum **bicavum,** p. 51.
M. **quercicolens,** p. 49.
M. **querneus,** p. 50.
New Records and Species of Neotropical Bark Beetles (Scolytidae: Coleoptera), p. 79.
New Records and Species of Neotropical Bark Beetles (Scolytidae: Coleoptera), Part II, p. 119.
New Species of Bark Beetles (Cole-

optera: Scolytidae), Mostly Mexican, p. 36.
Nixon, Elray S., Article by, p. 59.
Notes on Eriogonum III - On the Status of *Eriogonum pauciflorum* Pursh, p. 102.
Notes on Eriogonum V - A Revision of the *Eriogonum corymbosum* Complex, p. 183.
On the Earthworm Fauna of the Great American Desert and Adjacent Areas, p. 142.
On Two Little-Known Species of the Earthworm Genus *Diplocardia*, p. 1.
Phloeotribus **simplex,** p. 95.
Pityophthorus **festus,** p. 39.
P. **foratus,** p. 40.
P. **quercinus,** p. 40.
Predaceous-Scavenger Ants in Utah, p. 67.
Problems of Sampling Desert Arthropods Before and After a Thermonuclear Cratering Test, p. 26.
Pseudopityophthorus **granulifer,** p. 42.
P. **hondurensis,** p. 42.
P. **micans,** p. 44.
P. **tropicalis,** p. 43.
Pseudothysanoes **thomasi,** p. 38.
Reveal, James L., Articles by, p. 102, 177, 183.
Scolytodes **amoenus,** p. 128.
S. **clusiacolens,** p. 121.
S. **clusiavorus,** p. 122.
S. **facetus,** p. 126.
S. **ficivorus,** p. 125.
S. **ingavorus,** p. 126.
S. **nanellus,** p. 124.
S. **perditus,** p. 123.
S. **proximus,** p. 127.
S. **venustulus,** p. 124.
Scolytus **aztecus,** p. 120.
Spiders of the Nevada Test Site, p. 11.
Spinibdella **mali,** p. 98.
Stegomerus, p. 129.
S. **chiriquensis,** p. 131.
S. **mexicanus,** p. 133.
S. **montanus,** p. 132.
S. **pygamaeus,** p. 130.
S. **vulgaris,** p. 134.
Tanner, Vasco M., Article by, p. 230.
Tricolus **saundersi,** p. 139.
T. **spectibilis,** p. 140.
Wood, Stephen L., Articles by, p. 36, 79, 119.
Xyleborus **bicornatulus,** p. 137.
X. **horridatus,** p. 135.
X. **horridicus,** p. 136.

The Great Basin Naturalist

Founded in 1939 by Vasco M. Tanner

A journal published from one to four times a year by Brigham Young University, Provo, Utah.

MANUSCRIPTS: Only original, unpublished manuscripts, pertaining to the Great Basin and the western United States in the main, will be accepted. Manuscripts are subject to the approval of the editor.

ILLUSTRATIONS: All illustrations should be made with a view to having them appear within the limits of the printed page. The illustrations that form a part of an article should accompany the manuscript. All half-tones or zinc etchings to appear in this journal are to be made under the supervision of the editor, and the cost of the cuts is to be borne by the contributor.

REPRINTS: No reprints are furnished free of charge. A price list for reprints and an order form is sent with the proof.

SUBSCRIPTION: The annual subscription is $2.50 (outside the United States $3.25). Single number, 80 cents.

All correspondence dealing with manuscripts should be addressed to the Editor, Vasco M. Tanner, Great Basin Naturalist, Brigham Young University, Provo, Utah. Other matters such as subscriptions, reprints, exchanges and other business should be addressed to Ernest L. Olson, Chairman of University Publications.

REPRINTS SCHEDULE OF THE GREAT BASIN NATURALIST

	2 pp.	4 pp.	6 pp.	8 pp.	10 pp.	12 pp.	Each Additional 2 pp.
50 copies	$6.00	$7.00	$8.00	$9.00	$10.00	$11.00	$2.00
100 copies	7.00	8.00	9.00	10.00	11.00	12.00	
200 copies	8.00	9.00	10.00	11.00	12.00	13.00	
300 copies	9.00	10.00	11.00	12.00	13.00	14.00	

COVERS: $10.00 for first 100 copies, $4.00 for additional 100 copies.

TABLE OF CONTENTS

Notes on *Eriogonum* - V. A Revision of the *Eriogonum Corymbosum* Complex. Illustrated. James L. Reveal 183

D Elden Beck (1906-1967). Illustrated. Vasco M. Tanner 230

Index 240